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Between Foragers and Farmers in the Iron Gates Gorge: Physical Anthropology Perspective

Djerdap Population in Transition from Mesolithic to Neolithic [1]

Mirjana Roksandić
Max Planck Institute for Demographic Research, Rostock, Germany
Roksandic@demogr.mpg.de

ABSTRACT – *The research presented here aims at discerning possible interactions between Mesolithic hunter-gatherers of the Iron Gates Gorge (Serbia-Romania) and the surrounding Neolithic farmers during the 7th and the 6th millenniums BC. In order to examine the interactions of communities with different modes of subsistence (foraging and farming respectively), the nonmetric anatomical variants of the skull and postcranial skeletons were examined on the sites with the largest number of individuals buried. Another set of analyses, aimed at discerning environmental (occupation/nutrition) changes that could have affected the population in transition was performed on metric variables of postcranial skeleton. The combination of these two sets of analyses argues for local continuity within the region, with high degree of initial heterogeneity, and temporal ordering as the most likely explanation for the pattern of change.*

IZVLEČEK – *Naš namen je spoznati močne medsebojne vplive med mezolitskimi lovci-nabiralci v Železnih vratih (Srbija-Romunija) in sosednjimi neolitskimi kmetovalci v 7. in 6. tisočletju BC. Da bi ugotovili medsebojne vplive skupnosti z različnima načinoma preživljanja (lov-nabiralništvo in kmetovanje), smo raziskali nemetrične anatomske različice lobanj in postkranialnih skeletov z najdišč, kjer je največ individualnih pokopov. Opravili smo tudi analizo metričnih različic postkranialnih skeletov. Z njo smo želeli ugotoviti spremembe okolja (naselitev/prehranjevanje), ki bi lahko vplivale na skupnosti v tranziciji. Obe vrsti analiz kažeta na lokalno kontinuiteto z veliko začetno heterogenostjo in na časovno strukturiranost kot najbolj verjetno razlago vzorca spremembe.*

KEY WORDS – *Mesolithic; Neolithic; Iron Gates Gorge; non-metric traits; Lepenski Vir; Starčevo*

Dedication: To peoples and cultures, past and present, sacrificed to others' understanding of progress.

1. INTRODUCTION

The transition from foraging to agriculture can be regarded as one of the most fundamental cultural-ecological transformations that has occurred in the human career, as it enabled large scale sedentism, subsequent population growth, and the appearance of an urban way of life. Recent revival of interest in this phenomenon is witnessed by a number of edited volumes that discuss concepts of domestication and plant cultivation, the origin and spread of agricultural practices in different regions, as well as populational and social implications of the transition (*Cohen and Armelagos 1984; Gregg 1991a; Harris 1996a; Price and Gebauer 1995*). With the growing body of data from different regions, it has become apparent that agriculture developed independently in many areas of the world, and that modes of transition to food production from food gathering were specific for each individual geographic entity.

The study presented here aims to understand the patterning of the change from foraging to farming in the Lower Danube as reflected in the transition from Mesolithic "Lepenski Vir" culture to Neolithic "Starčevo" complex in the Iron Gates Gorge in Serbia

1 This paper is based on the Doctor of Philosophy Thesis defended at Simon Fraser University before the Committee: Dr. Ruth Tringham, Dr. Christopher Meiklejohn, Dr. Jonathan Driver, Dr. Jack Nance, and Dr. A. Catherine D'Andrea.

Fig. 1. Iron Gates Gorge in May 2000. On the left side of the photo the clearing of the submerged Hajdučka Vodenica terace. The other sites are located further upstream.

(Fig. 1). Since a long period of coexistence of the Mesolithic and Neolithic ways of life in this region has been proposed (*Radovanović 1996b*), this research will attempt to reconstruct the extent and mode of interactions between farmers and foragers through the examination of skeletal material from four of the most important sites excavated in the region: Lepenski Vir, Hajdučka Vodenica, Vlasac and Padina.

1.1. Theoretical background

It is generally accepted that methods of food production, together with the cultigens, were introduced to Europe from the Near East *via* Greece and the Balkan Peninsula. The mode of transition was either the transfer of farming techniques to indigenous populations with practically no genetic admixture, the migration of farmers themselves, or both. The archaeological data alone do not permit the distinction between these modes even if they were mutually exclusive. Based on genetics of living European populations, Cavalli-Sforza proposed the model of "demic diffusion", which argued for the spread of agriculture by migration of people from the southeast to the northwest, at an average pace of 1 km a year (*Ammerman and Cavalli-Sforza 1984*). In later publications, this model came to incorporate the transfer of technology as a part of the process (*Cavalli-Sforza 1996*). Assimilation of foragers by farmers, through deforestation and acceptance of agricultural practices (competition and acculturation) and marriages of hunter-gatherer women to farmers (acculturation), would have created the "gradient" observed in the Principal Component Analysis (PCA) of genetic data. The underlying assumption of the model, that the Mesolithic population was sparse throughout Europe, has been questioned by recent paleodemographic studies (*Meiklejohn et al. 1997*).

In the extremes of the European periphery (Scandinavia, Portugal, Spain, Baltic States) this model has been questioned by the survival of Mesolithic cultures in proximity to incoming Neolithic ones (*Price 1996; Thomas 1996; Zvelebil 1996a*). The craniometric analyses of European prehistoric samples failed to provide support for the model of population replacement (*Harding et al. 1989*). Further, coexistence and mutualistic exchange that was proposed recently for Central Europe, as opposed to confrontation and acculturation, provides a more likely and flexible context for understanding the early interactions of farmers and foragers (*Gregg 1988, 1991b*). Given the fact that the first farmers were moving north into essentially unknown habitats, and progressively more marginal climatic conditions for the production of their newly domesticated plants, while the foragers were long time inhabitants with excellent knowledge of seasonal food availability, it is unlikely that the neolithisation of Europe could have been as swift without involvement of local Mesolithic inhabitants (*Prinz 1987*).

1.2. Relevance of this study

Most of the studies that propose models for Europe as a whole, are based on the spread of the "Linear Bandkeramik" culture that is limited to Central Northwest Europe and, in terms of European periodisation, contemporaneous with the Late Neolithic cultures of the Southeast (Vinča, Dimini, *see* Table 1). The first manifestations of the Neolithic in southeastern Europe precede Linear Bandkeramic culture and show significantly different economic and social patterns. Neither the spread of "Cardium-impresso" culture in the circum-Mediterranean region, nor the apparent processes in the Aegean or Balkans conform to the demic diffusion model.

The comparatively understudied Balkans are rarely discussed in theoretical literature except for the absolute dates, which are usually applied without reference to the "cultural" or socio-economic background and are used to argue the direction and the pace of migration. In order to build larger geographic models, it is crucial that areas of Europe that have not been carefully examined become the focus of a critical study. Further, as neolithisation of southeastern Europe precedes the neolithisation of the rest of the continent, understanding the processes and those attributes of Mesolithic in the area that allowed for the rapid neolithisation is of extreme importance. The goal of this research, and of the ongoing work by the team of researchers from the Institute of Archaeology and the Departement of Archaeology in Belgrade, is to make the Iron Gates Gorge material accessible for comparison with that from other regions of Europe and thus provide a basis for building sensible models of neolithisation of the continent.

Archaeological and anthropological study of the material from the Iron Gates Gorge (Figs. 1 and 2) is supported on a number of bases:

- the neolithisation of this area preceded the neolithisation of all other parts of Europe except the Aegean;
- the extent of excavations of a number of sites on both banks of the Danube has been unparalleled in the last three decades as it has exposed substantial living surfaces amenable to detailed archaeological analyses;
- the sites provide insight into both cultural and populational consequences of the transition through abundant architectural features, artefacts, faunal, palynological and osteological remains and;
- since the coexistence of the Mesolithic foragers, belonging to the Lepenski Vir culture, and Neolithic Starčevo farmers has been established (*Boroneanţ et al. 1995; Radovanović 1996a; 1996b*), the degree and mode of interaction between them can potentially be traced in both archaeological and osteological remains.

1.3. The Lepenski Vir culture

Material remains of the Mesolithic Lepenski Vir culture have been uncovered on a number of sites in Iron Gates Gorge and dated from 7500 to 5800 BC. The culture is characterised by a sedentary or semi-sedentary foraging economy based on varied and abundant resources provided by the Danube and adjacent mixed growth forests. A long period of cultural stability, complex social organisation and developed religious beliefs can be postulated from remarkable architectural achievements and expressive monumental sculpture. Most of these sites are at least partly contemporaneous with farming communities of the Gura Baciului, Anzabegovo, Starčevo and Karanovo type (*Gimbutas 1976; Jovanović 1984; Radovanović 1992; Srejović and Letica 1978*). However, throughout the period when contact was possible, Lepenski Vir culture did not change significantly, and the pressure from the outside served more to seal the bonds between different Iron Gates Gorge sites, than to undermine their cultural or economic unity (*Srejović 1978; Radovanović 1996c; 1996d*).

Iron Gates Gorge	Karpathian Pannonian Balkans	Macedonia	Bulgaria	Thessaly	Central Europe	Date BC ca.
	Vinča	Vinča	Karanovo IV	Dimini	LinearBand Keramik	5000
Starčevo IIB	Starčevo Körös Cris	Vršnik	Karanovo III	Early Neolithic III (Sesklo)		5500
Lepenski Vir	Starčevo Körös Cris	Vršnik	Karanovo II	Early Neolithic III (Sesklo)		6000
Lepenski Vir	Gura Baciului	Anzabegovo I	Karanovo I	Early Neolithic II (Proto Sesklo)		6500
Lepenski Vir						7500

Tab. 1. Schematic representation of the chronological relationships between geographic regions in Southeast Europe. Dates BC only approximate.

Osteological material that is central to my research comprises 362 or more individuals from four sites of the Lepenski Vir culture: Padina, Hajdučka Vodenica, Vlasac and Lepenski Vir. These four sites, situated on the south bank of the Danube and characterised by sophisticated architectural remains, were chosen for their large number of burials. This is one of the two largest skeletal series that span the Mesolithic to Neolithic transition in Europe. The time period they cover is over 1500 years. The other large series comes from sites in Russia and the Baltic States. In addition, the restricted regional distribution makes this sample more meaningful and amenable to statistical analyses than the Russian and Baltic material. Since basic metric analyses have been done, at least for Lepenski Vir and Vlasac (*Mikić 1981a; 1981b; Nemeskeri and Szathmary 1978a; 1978b; 1978c; 1978d; 1978e*), and odontometrics for Vlasac (*y'Ednak and Fleich 1983*), and in the view of partial inhumations and unequal preservation of individual skeletons, I have decided to concentrate on the distribution of non-metric anatomical variants as the most relevant measure of population distances.

2. THE PROBLEM OF DISTINGUISHING MESOLITHIC FROM NEOLITHIC

Although the Mesolithic is a well-established term in archaeological literature, its exact meaning remains susceptible to differing interpretations. Since the focus of this work is the Mesolithic population of the Iron Gates Gorge and its presumed contact with Neolithic peoples, and since the debate over the meaning of this term has historically played an important role in discussions between principal investigators of the Iron Gates Gorge sites (*Boroneanț et al. 1995; Jovanović 1972; Srejović 1971; 1979; Srejović and Letica 1978*), it is important to provide clear definitions of both Mesolithic and Neolithic as they are used here.

2.1. Definition of terms

2.1.1. Mesolithic

In 1865, John Lubbock divided Prehistory into the Old Stone Age - "Palaeolithic" characterised by flaked stone, and the New Stone Age - "Neolithic" - characterised by the introduction of polished stone implements. This division was formal and typological. It enabled archaeologists to assign finds into two global categories of prehistoric technology. The first to coin the term "Mesolithic" was Hodder M. Westropp who in 1872 used it to denote everything from "Reindeer period caves" until the introduction of agriculture, therefore both Upper Palaeolithic and Mesolithic as we use it today (*Rowley-Conwy 1996*). At about the same time M. Reboux, independently introduced the term in France to describe an industry intermediate between those that he defined as producing only flakes (such as Levallois and Mousterian in general) and those that produced polished axes, essentially including the same time span and typology as Westropp (*Orliac 1988*). Although his classification was not accepted, the term "Mezolithique" came to live on in the work of Archibald Carlyle who applied it to an industry of "small geometric flints" found in India (*quoted in Orliac 1988*). The temporal notion was introduced in 1893, by an antiquarian Allen Brown, who used the term to describe those cultures of the Holocene that existed

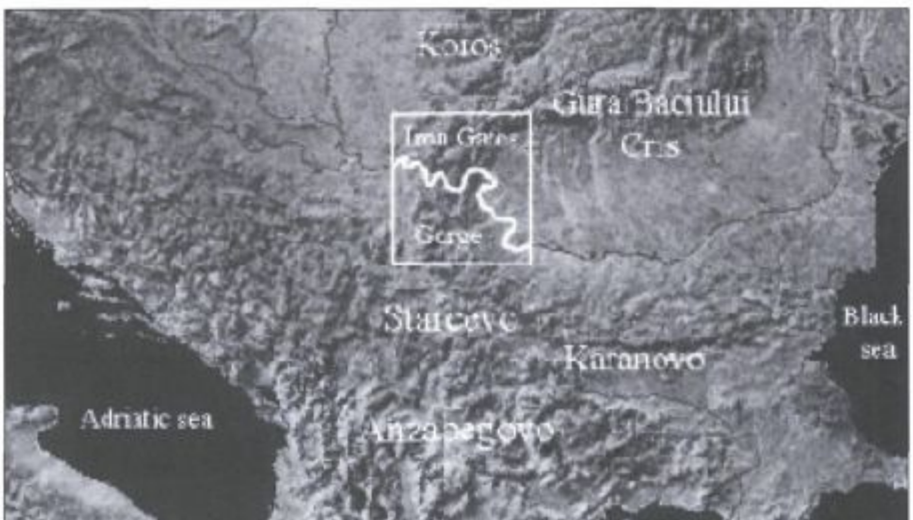


Fig. 2. Satellite map of the Pannonian Plain, Karpathian Basin and the Balkan Mountains. Flowing through the Pannonian Plain, the Danube enters the Karpathian Mountains and forms the Iron Gates Gorge (outlined by the white square). The Early and Middle Neolithic cultures that are partially contemporaneous with Lepenski Vir culture are outlined in the centers of their respective areas. (*Adapted from NCARTA 1998*).

before the introduction of agriculture (*Pedersen pers. comm.*). According to Orliac (*1988.686*), the widely spread definition that viewed as "Mesolithic all the industries between Magdalenien and Neolithic" was introduced by J. de Morgan in 1909.

Current definitions can be classified in two major groups: one typological and the other chronological. For the proponents of the typological definition the characteristics of flint industry (such as the appearance of microliths) have the most decisive value. Orliac proposes that those industries situated between Palaeolithic and Neolithic that possess "characters sufficiently different from those of the industries of the two periods" (*Orliac 1988.686*) should be determined as Mesolithic. Although it may be appropriate for western European archaeology, even though "sufficiently different characters" remain essentially arbitrary and ambiguous, the definition falls short in other areas of the world. For proponents of chronological definition all hunter-gatherers of the Holocene are regarded as Mesolithic, regardless of whether they show differences from the Palaeolithic hunter-gatherers. Since it would include a number of communities in the Holocene that continue with essentially the same mode of food procurement and mobility patterns as their Pleistocene counterparts as well as significantly different groups, the need to introduce 'Mesolithic' as a different term is not as obvious.

Introduction of economic parameters "that the [term] never had historically" (*Orliac 1988.686*) has, in a number of cases, led to economic determinism, which includes an open or subdued notion of evolutionism. Distinction is made between the Epipaleolithic – in which Holocene adaptation does not produce any changes in way of life and lithic technology (*Kozłowski and Kozłowski 1986; Leroi-Gourhan 1965*) and the Mesolithic – with its substantial changes in economy, ecology, and material culture (*Kozłowski and Kozłowski 1986*). The latter would be found only in innovation zones leading to food production (*Leroi-Gourhan 1965*), or enabling change from food collection to food production (*Clark 1980*). This definition supposes a unidirectional evolution towards food production and contradicts the data from large areas of the world where substantial changes in economy, ecology and material culture did not lead to introduction of agriculture (e.g. West Coast of Canada).

In order to overcome chronological and typological ambiguity, as well as economic determinism characterised by an implicit evolutionist basis, Radovanović (*1996a.14*) argues that a qualitatively different phenomenon, capable of distinguishing archaeologically Mesolithic groups from those of the Palaeolithic and Epipaleolithic, can be found in the appearance of formal disposal areas for the burial of the dead. Formal disposal areas need not be a phenomenon separate from the habitation site, as that would exclude all western and central European sites (*Meiklejohn pers. comm.*), with the exception of the newly excavated Mesolithic necropolae in France (*Duday and Courtaud 1998*) and Belgium (*Cauwe 1998*). They are determined as "...areas of continuous, ceremonial, mortuary disposal" (*Radovanović 1996a.14*). Further, they are an archaeologically visible phenomenon that is interpreted as arising from the need to lay claim on the territory by its ideological integration (*Chapman 1981*) [2]. The need to claim territory, in turn, would arise from a combination of linear rather than hexagonal arrangement of units within one hunter-gatherer group or higher than usual population densities (*Gamble 1986.52–53*), and a hunter-gatherer economy based on intensive exploitation of a vital resource, or a greater variety of resources in the vicinity, with semi-sedentism or sedentism. This would result in a structural complexity of the social unit (*Srejović 1979*) usually expressed through developed ancestral and mortuary rituals. While the appearance of formal disposal areas for the dead does not necessarily arise exclusively from the concerns of territoriality, and while they are not associated exclusively with the Mesolithic, their appearance is a clear sign of changing times in prehistory associated with changes in the social arena (*Chapman 1993*). However, although they are an archaeologically visible element, they are not the only one that enables recognition of a site as Mesolithic. Furthermore, as they allow for different interpretation and understanding of what constitutes a formal disposal area, they are not necessarily the best element for classification.

The introduction of economic parameters and, even more importantly, mobility patterns, once evolutio-

2 Although this monocausal explanation that was applied to all the mortuary monuments in Neolithic Europe is overly simplistic, and reveals more about the preoccupations of modern-day western scholars than prehistoric inhabitants of Europe (*cf. Cullen 1995.286*), it remains one of the possible, and even plausible reasons, but can not be perceived as the only cause of the arising importance of mortuary ritual in the period (*Masset 1993*).

nist connotations are removed, has the potential to make this term more meaningful and appropriate for regions where the distinction of Mesolithic from Palaeolithic and Neolithic, based on flint, stone and bone industries, is not as straight-forward as in France (for example, since microliths in Africa appear as early as 70 000 BP), or where ceramics (traditionally associated with the Neolithic) appear earlier than agriculture, as for example in the Jomon (*Imamura 1996*) or in Scandinavia (*Werbart 1998. 37, and quoted literature*).

This innovation and change in adaptation is usually linked with intensification of exploitation of one or more abundant resources (*r*-resource) as opposed to exploitation of a *K*-selected resource (*see Gamble 1986.41*) that characterises mobile hunter gatherers. The availability of an abundant and stable resource that can be exploited in the relative vicinity of the camp has been linked to reduced mobility. This combination seems to be determinative of Mesolithic settlements. For example, the specific climatic conditions of the Iron Gates Gorge, the refugial character of its flora, and the great variability of plants without a dominant species where 44% of the 371 species of plants are useful in human, and 59% of them useful in animal nutrition, has enabled intensification of both settlement and exploitation. However, throughout the period, the terrestrial animal component (*K*-resources) remains dominant (*Radovanović 1996a. 37*) and although fish is deemed an important resource providing the bulk of the protein during the Mesolithic (*Bonsall et al. 1997*), Radovanović argues that its role is more *vital* than dominant, thus providing a buffering mechanism in periods of scarcity, rather than being a year round staple. Either way, its availability becomes the key factor enabling different spatial distribution of settlements and other features of Mesolithic organisation.

Structural complexity, seen as a segmentation or an increase in the parts that make up the whole (*Kent 1989a.10*), could arise from changes in mobility patterns and increased sedentism which results in population increase and the need for an arbiter in settling disputes (*Lee 1972a; 1972b*). However, it can not be taken for granted and must be demonstrated by independent data in many areas of the world where it has been assumed (*Brinch-Petersen and Meiklejohn in press*).

Moving in full circle from cause to the effect, that in its turn becomes a cause, rises a complex picture of interacting forces of environmental productivity, sedentism motivated by linear distribution of resources or their availability, and causing social restructuring. Structural complexity arissing from sedentism, causing further environmental changes. Together with sedentism, the latter influences mortuary ritual, while mortuary ritual in turn influences both sedentism and social structure.

In the context of this study, and for the area in question, the Mesolithic is best defined as primarily based on intensified exploitation of food resources on a limited territory with reduced mobility. Settlement distribution and mobility patterning, interacting with more intensive exploitation of *r*-resources (plant or fish), and aggregation necessary for tasks demanding cooperative effort, can be regarded as both determinative of the Mesolithic and as providing sufficient archaeological visibility. Within the Iron Gates Gorge, regardless of whether fish played a key role as staple or as a vital resource, its availability is the *sine qua non* of reduced mobility (*sensu Kent 1989a*) and the change in its exploitation provides clear evidence of the Mesolithic economy and social organisation.

2.1.2. Neolithic

Proceeding from the typological classification of prehistory, the Neolithic in Europe has been regarded as a period when polished stone was introduced, alongside ceramic production. This typological distinction was questioned with further developments in archaeology, especially the excavations of "pre-pottery Neolithic" in the Levant (*Wright 1992*). An economic definition in which "the shift in mode of subsistence to agro-pastoral farming remains the only process that is relatively clearly defined, geographically widespread and sufficiently archaeologically detectable" to act as a signature of the Neolithic (*Zvelebil 1996b.625*) is widely accepted and both ethnologically and archaeologically traceable. Preceding and subsequent changes in social structure, ideology or any other aspects of life need to be examined on a regional basis. The other two questions, that of how much evidence of plant manipulation and animal husbandry constitutes enough evidence (*sensu Harris 1996a and quoted literature*), and whether a horticultural stage of farming economy - characterised by lack of impact on the environment (*Willis and Bennet 1994*) - can be perceived as agriculture, also need to be regarded on a local scale. In Southeast Europe, the introduction of cultigens and domestic animals from the Near East solves this problem, as these are not found in the wild. Their introduction indicates a shift in subsistence strategy and reliance (at least partial) on imported cultigens.

2.2. The Iron Gates Gorge context

In terms of the Iron Gates Gorge, this semantic discussion is by no means unimportant. Interpretations for Lepenski Vir - Schela Cladovei culture range from Epipaleolithic (*Boroneanţ 1969; Lazarovici 1979; Letica 1971*), Protoneolithic (*Srejović 1968*), Epipaleolithic in its early and Protoneolithic in its late phase (*Srejović 1979*), Mesolithic (*Prinz 1987; Srejović 1989; Voytek and Tringham 1989*), to Mesolithic and Early Neolithic (*Jovanović 1972; 1974*). This variety stems to a great degree from the above mentioned definitions: one chronological, in which Holocene hunter-gatherers are differently viewed as Mesolithic or Epipaleolithic; and the other based on material culture where microliths are taken as a telltale sign of the Mesolithic, while ceramics, polished stone axes and adzes are used as markers of Neolithic (*for discussion and appreciation of the theoretical positions in these different approaches see Radovanović 1996a*). Littoral distribution of the sites in the Iron Gates Gorge that resulted in reduced mobility or possibly even sedentism, increased social complexity evidenced by specialisation of ritual *vs.* domestic activities (*Srejović 1979, but see Chapman 1993*) and increased population aggregation (*Jackes et al. 2000*) are all very prominent features of Mesolithic components on the sites of this culture. Neolithic in the region is characterised by introduction and reliance, at least partial, on the Near Eastern cultigens and livestock. Although hunting, fishing and gathering remain important in the region, the proportion of domesticates *vs.* wild fauna and flora is sufficient to argue for the introduction of Neolithic economy.

Crucial to our understanding of the Iron Gates Gorge Mesolithic/Neolithic transition is the period of the coexistence of these two modes of life in the immediate proximity (Fig. 1). It is evidenced by both ^{14}C dates and Starčevo ceramics and flint blades within Mesolithic strata of the Lepenski Vir culture. This period witnesses the coexistence, communication, trade and interaction between Lepenski Vir hunter-gatherers and Starčevo farmers. It is in this light that the semantic discussion of the two terms becomes increasingly important for understanding archaeological data[3].

Therefore, if intensification of exploitation of food resources, on a limited territory with reduced mobility, characterises the Lepenski Vir Mesolithic, then all strata within these sites that do not have evidence of food production and/or introduced domesticates (*above 5% as suggested by Zvelebil 1996a*) should be regarded as Mesolithic. If we accept that Neolithic in the region is characterised by introduced cultigens and livestock, then evidence for food production and appearance of these cultigens in the strata should be regarded as crucial for identifying them as Neolithic. In this perspective, the sporadic appearance of Starčevo (Neolithic) type ceramics and Starčevo blades in Mesolithic strata, i. e. Mesolithic type house with ceramics *in situ* (*Jovanović 1984*), requires explanation. A porous agricultural frontier with transfer of knowledge, material items, and individuals across the board (*Zvelebil 1996a*) offers a reasonable model, if we accept that this exchange could have involved both different direction and different form over this long period of coexistence.

2.3. Forager – farmer's interactions: possible scenario(s) for Europe

Historically, the role of local forager populations has received little attention. This is due to the perception of human culture as "developing" over certain immutable stages, through which every society would eventually have to pass (*Childe 1936; 1951; Engels 1972 /1884, see also: Earle 1994, for an overview of different classificatory models*), and since the spread of farming into Europe was modelled on the spread of European agriculturists into the New World (*Atley and Findlow 1984*), these populations, more than their Palaeolithic predecessors, cave painters and big game hunters, were perceived as insignificant because of an almost complete lack of art and their microlithic industry (*Clark 1978.2*). A considerable amount of evidence in the last quarter of the century has shown that many prejudices toward hunter-gatherers in general, and Mesolithic peoples in particular, were unjustified[4]. Hunter-ga-

3 It became apparent in my numerous discussions with Dr. Jovanović at the Institute of Archaeology that we were using Mesolithic to denote quite different phenomena. Once we passed this barrier, the largests gaps in our respective interpretation were bridged.

4 Although they are only rarely explicitly present in up-to date archaeological literature, it is not so for other disciplines: see Rodrigue (*1992*) for a critique of current perception of domestication by cultural geographers who regard ritual sacrifice as major impetus for domestication of animals and portray preagricultural populations as: "*roving* and *hungry* hunters and gatherers," while farming is perceived "as creating leisure time" (p. 417 and quoted literature, my italics). It is possible to observe that there is practically no interaction between human geography on one hand, archaeology, and anthropology on the other, or else this statement could hardly be understood given recent insight into different subsistence strategies and their work-loads.

therers around the world "have for many millennia routinely manipulated plant and animal populations in diverse ways to optimise their use of them" (*Harris 1984; Harris and Hillman 1989; and examples quoted in Dennell 1985*). Farming and foraging are considered as "overlapping, interdependent, contemporaneous, coequal and complementary domains in the Amazonia" (*Sponsel 1989.37*).

Hunter-gatherers and agriculturists coexisted in many parts of Europe for several centuries, and in some areas, for millennia. Early farming communities were scattered amongst predominantly forager populations, and, depending on many of the historical contingencies, the spread of agriculture was sometimes rapid, sometimes gradual. It even retreated at times or showed no change over long periods of time (*Dennell 1985.113*). The interactions between these populations were inevitable, and our perception of their frontiers, communications and avoidance strategies has been largely improved from information gathered by cultural anthropology on recent foragers and farmers.

It is very important to stress, when dealing with past human populations, that our perception of possible interactions needs to remain open-ended so that interactions can be perceived as changing and fluctuating. Primarily, this is important since patterns of recent interactions are at least partly determined by the growing marginalisation of both subsistence farmers and foragers in the global industrialised economy. Secondly, the archaeological record preserves only a very limited portion of total interactions, namely, those that concern exchange, and can therefore only rarely provide insight into other aspects of it. Further, archaeology operates within time frames that largely surpass our personal experiences: since interactions between local foragers and farmers in the Iron Gates Gorge, in Portugal, or in Denmark, spread over almost one millennium, it would be unreasonable to think that they remained the same throughout that period and that they were always characterised by either mutualistic exchange or warfare. Also, the perception of cultural unity, as shown by recent research on interactions of foragers with farmers, does not necessarily stem from the same mode of life and "models of interaction which make insufficient allowance for the lack of coincidence between ethnic grouping and mode of production or the influence of different societies on each other may need to be revised" (*Jolly 1996.234*). The archaeological record produced by people belonging to two clearly distinct ethnic groups, one pastoralist, the other hunter-gatherer, can leave very similar material remains, which are determined neither by economy nor ecology, but by intention or anticipated mobility (*Kent and Vierich 1989*).

Perception of subsistence farmers as dominant over hunter-gatherers in recent small-scale societies has been fairly well documented (*Speth 1991 and quoted literature*). This current perception could result from the actual physical and numerical dominance of agriculturists in the modern world and would be irrelevant for the patterns of perception in prehistory. In all instances observed in contemporary populations, cultural traits move from dominant farmers to their neighbouring foragers (*Hodder 1982*), while women from foragers groups move into their neighbouring dominant farmer units (*Speth 1991; Zvelebil 1996a*). Although many mythological and ritual practices have unrestricted and bi-directional flow from one society to the other (*Lewis-Williams 1996 and quoted literature*), hunter-gatherers participate in farmers' initiation rituals and not *vice versa* (*Turnbull 1961; Jolly 1994*).

Current patterns of domination could stem from the fact that modern farmers are less dependent on forest products than foragers are on carbohydrates (*Speth 1991 and quoted literature*). The situation could have been very different at the time of the spread of agriculture into Europe. Therefore, extrapolating current perception as relevant for past human societies unreasonably assumes that agriculture had greater objective value than foraging, and would therefore be necessarily perceived as a better cultural adaptation by both farmers and foragers of the past. In prehistoric Europe it could be expected only within the context of the late Neolithic/Chalcolithic, when farming starts having a serious impact on the environment (*Willis and Bennet 1994*). Only in that context could hypergyny at an agricultural frontier result in the acculturation of foragers (*as suggested by Zvelebil 1996a.338*). Before that, this perception would fluctuate as determined by local and chronological dependence relationships between foragers and farmers. Hypergyny, or the practice of "women of low socio-economic status to move up the status hierarchy, marrying less fortunate men in higher social categories who must marry down to find a mate" (*Speth 1991.20*), commonly observed in these interactions today, would not necessarily mean that hunter-gatherer women would marry into farmers' villages. At least in certain regions where foragers would be numerous, sedentary, and with sophisticated social organisation, as in the Iron Gates

Gorge, they could have been perceived as dominant by small-scale farmers. Hypergyny would, then, take on a different direction.

Optimal forager models for subsistence transitions argue that "sharper growth is not associated with broader diet but with subsequent increases in handling efficiency associated with practices that result in domestication" (*Hawkes and O'Connell 1992 and quoted literature*). Population growth rates would, therefore, decline with expanding diet breadth in the Mesolithic and would increase with improvements in the handling during Neolithic (*Hawkes and O'Connell 1992*). This conclusion, however, disregards the role that sedentism had on population growth, changes in subsistence and social complexity (*Kent 1984; 1989a*). It is becoming increasingly evident that both hunter-gatherers and farmers can and do have different mobility patterns that are both ecologically and socially sensitive (*Kent 1989b*), and that these patterns cannot be classified as a simple dichotomy. This pattern is primarily, though not exclusively, determined by the distribution and seasonality of plant (or anadromous fish) resources, not animals (*Kent 1989a.11*). Intensification and localisation of resource exploitation leads to further sedentism, and importantly, aggregation which results in population increases (*Kent 1989a.10 and quoted literature*). Sedentary aggregations result in the need for an arbiter, as disputes can no longer be settled by mobility, as for example in Hadza (*Woodburn 1968.106*). The immediate consequence of arbiter becomes incipient political differentiation concomitant with changes in social organisation.

Since it is also known that many sedentary horticulturists hunt and manipulate plants for higher yields on a regular basis (*Kensinger 1989; Speth and Scott 1989 and quoted literature*), a clear-cut distinction between hunter-gatherers and small scale farmers can not always be made. This is no less true for modern societies than for the Early Neolithic of Europe. If we accept that agricultural practices are only those that "create(s) agroecosystems, which limit subsistence choice because of environmental transformation or labour demands" (*Harris 1989; 1996b; Spriggs 1996*), they could include the early Neolithic of south-eastern Europe as evidence for agriculture, although they had little observable impact on environment.

2.4. Neolithisation of Europe

As already stated, the transition from foraging to agriculture can be regarded as one of the most fundamental cultural-ecological changes not only because it enabled large scale sedentism, subsequent population growth, and the appearance of the urban way of life, but also as it represents a conceptual shift in the perception of the world. Recent revival of interest in this phenomenon has brought about the understanding that agriculture developed independently in several areas of the world, and that modes of transition to food production from food gathering are specific for each individual geographic entity, and dependent on a number of particular conjunctions of circumstances in particular places at particular times (*Harris 1996b.552*). This revival has also stressed the importance of Upper Palaeolithic and Mesolithic adaptations for the development of the incipient agriculture, since small-scale cultivation is practised by many hunter-gatherers (*Harris 1989; 1996b; Spriggs 1996*).

It is generally accepted that methods of food production, together with cultigens, were introduced to Europe from the Near East *via* Greece and the Balkan Peninsula. Einkorn, emmer, naked wheat, six row barley, lentils and peas, all imported corps, show up in Early Neolithic settlements in Macedonia, Serbia and Bulgaria (*Zohary and Hopf 1988.191– 193*), while evidence for the introduction of domestic sheep predates full agropastoral economies in the Western Mediterranean (*Donahue 1992; Geddes 1985*). If the problem of origin of cultigens and knowledge of agriculture is solved, the mode of transition and the respective roles of hunter-gatherers and farmers remain unclear. Two major models are proposed: one involving the spread of farmers themselves, and the other based on appropriation of the new method of food production by indigenous foragers.

Since the beginnings of European archaeology, the transition from foraging to farming has been regarded as a replacement of European Mesolithic cultures and populations by Neolithic ones, that spread through colonisation by Near Eastern farmers (*from Lubbock 1865; to Harris 1996c*). The Epipaleolithic and Mesolithic population was perceived as sparse to the point that until the 1950s it was generally believed that no important developments occurred between the Upper Palaeolithic and Neolithic in Europe (*Clark 1980*).

Childe's (*see for example Childe 1958*) evolutionist understanding of the benefits of agriculture culminated in Ammerman and Cavalli-Sforza's (*1971*) theory which was to become one of the most influential models: wave of advance or "demic diffusion."

This interpretation is based on the comparison of the available ^{14}C dates and the genetics of living European populations (*Ammerman and Cavalli-Sforza 1971*). The authors argue for the spread of agriculture by the more or less continuous migration of people from the southeast to the northwest, at the average pace of 1 km a year (or 25 km per generation) with continuing population growth immediately following the advancing front of agricultural settlement (*Ammerman and Cavalli-Sforza 1984*). In later publications, the model came to incorporate the transfer of technology as a part of the process (*Cavalli-Sforza 1996*). Assimilation of foragers by farmers, through deforestation and acceptance of agricultural practices (competition and acculturation) and marriages of hunter-gatherer women to farmers (acculturation), would have created the "gradient" observed in the Principal Component Analysis (PCA) of genetic data.

Authors such as van Andel and Runnels (*1995*) accepted and attempted to moderate this view. Since early Neolithic settlements in both Anatolia (*Roberts 1991*), and southeastern Europe (*van Andel and Runnels 1995*) were characterised by small scale and locally intensive cultivation (*Sherratt 1980*) and situated in areas, at least in the Balkans, that were not occupied by indigenous Mesolithic populations, they argued that migration occurred in discrete steps, "the interval dictated by geography and by the population growth in each of a slowly rising number of parent areas" (*van Andel and Runnels 1995.497*). Cavalli-Sforza argues for expansion rather than migration, as the former involves both population growth and replacement (*Cavalli-Sforza 1996.56*). He also endorses Renfrew's equation of this population as Indo-European speaking (*Renfrew 1996*)[5].

In a recent critique, Fix (*1996.627–628*) has shown that the parameters that Cavalli-Sforza and colleagues used are far from well defined and fixed. He argues that clinal patterns such as those observed in European populations also can be produced by temporal gradients in natural selection. A similar opinion was forwarded in early 1980s by Meiklejohn (*Meiklejohn 1985*). The selective factor would be increasing disease intensities brought about by the "diffusion of agriculture, and especially, by the association between humans and newly domesticated animals" (*Fix 1996.625*). Although the cause of clinal distribution would be agriculture, the mechanism of its spread need not be movement of population. It could, just as well, result from natural selection acting on a local population that has changed (through transfer of ideas and otherwise) its cultural (subsistence) practices (*Fix 1996.641*). Fix is aware of the problems associated with the proposed model: namely it is very difficult to demonstrate small fitness differences for many loci, and prove the association of the origin of certain diseases with domestication of animals, but his model is important as it proposes another look at the data and argues that it is "mistaken to use loci such as HLA, for which there is strong evidence of selection, as neutral markers of population movement" (*Fix 1996.641*). The two models discussed contrast most sharply in the demographic mechanisms for generating the clines and therefore Fix concludes that "knowledge of the population characteristics of the Mesolithic and Neolithic peoples could decide the issue" (*Fix 1996.641*). Further, the craniometric analyses of European prehistoric samples failed to provide support for the model of population replacement (*Harding et al. 1989; but see Petersen 1997*).

If, as proposed by Cavalli-Sforza (*1996*), not only farming, but farmers themselves originated in the Near-East and then expanded into Europe, it would require that the Near East was a "demographic cistern" that overflowed its surplus to Europe (*Dennell 1985.119*). Early and Middle Neolithic farming communities are rare and small in size in southeastern Europe, and even in the Near East early farming populations seem to have been very low in numbers. Inclusion of local foragers into the genetic pool through hypergyny and acculturation would only have marginal importance in this initial phase according to the clinal distribution of PCA and the isochronic map that is used to support the "demic diffusion" model.

The Mesolithic population of Europe was interpreted as highly homogenous, showing a high degree of similarity with preceding Upper Palaeolithic people (*Henke 1989.541*) with clinal distribution and a continuous gradual change over time. This was suggestive of intensive gene flow between Late Pleistocene and Early Holocene populations in Europe. In Henke's view, "due to a low population density there were continuously, partly overlapping mating networks without any greater barriers to gene flow" (*Henke 1989.560*). The low population densities would increase only later in the Mesolithic with a tribal level of social organisation that was either of

5 For an exellent critique see Sergent (*1995*).

a short duration, or was not prevalent and therefore did not lead to genetic isolation (*Constandse-Westermann and Newell 1989; Constandse-Westermann et al. 1984*). Bocquet-Appel (*1985*) suggested that small populations could avoid extinction only by means of high migratory flow, involving interpopulation gene flow and exchange over large geographic areas. Because of this model and the supposed scarcity of resident hunter-gatherer populations, their role in the process of introduction of agricultur "has been disregarded or minimised" (*Meiklejohn and Zvelebil 1991.129*). That the Mesolithic population was sparse throughout Europe, has been questioned by recent paleodemographic studies (*Jackes et al. 2000; Meiklejohn et al. 1997; Jackes et al. 1997*). However, a careful reading of the argument by Constandse-Westermann and Newell points to a greater regional sedentism in the Late Mesolithic and may not be in contradiction with current archaeological or demographic evidence, although Danish material seems to cast considerable doubt on this concept (*Meiklejohn pers. comm.*). As with many other lines of inference, recent paleodemographic studies of Portuguese and Danish material have shown that the picture is not only complex but also region-specific (*Meiklejohn et al. 1997; Jackes et al. 1997*).

Given the fact that the first farmers would be moving north into essentially unknown habitats, and progressively more marginal climatic conditions for the production of their newly domesticated plants, while the foragers were long time inhabitants with excellent knowledge of seasonal food availability, it is unlikely that the neolithisation of Europe could have been as swift without involvement of local Mesolithic inhabitants (*Prinz 1987*). Coexistence and mutualistic exchange that was proposed recently for Central Europe, as opposed to confrontation and acculturation, therefore provides a likely and more flexible context for understanding the early interactions of farmers and foragers (*Gregg 1988; 1991b*). As Dennell points out (*1985.118*) lack of evidence for defence structures around early farming villages argues for peaceful interactions rather than raiding and warfare. This is not only in sharp contrast with later societies in temperate Europe but also strongly contradicts the attempt to equate incoming farmers with Indo-Europeans as Renfrew (*1996*) does. However, idealistic peaceful interactions have been contested by L. Keeley (*1997*) who argues that the transition to agriculture in central and northern Europe offers evidence for substantial amount of violent relationships, especially in the western realm of the Linearbandkeramik (LBK) spread.

The diffusionist point of view, so influential in English-speaking archaeological tradition was criticised as early as the 1970s by Garašanin (*1973; 1974b*), and greater emphasis was placed on understanding local Mesolithic populations as active participators in the process of neolithisation (*see also Guilaine 1976*). Price's conclusion (*1983.771*) that "the end of the Mesolithic is not brought about by an advance of invading farmers but rather reflects a period of readaptation and adjustment to changing environments and new subsistence practices, *often within the context of existing societies*," stresses the importance of adaptations of Mesolithic foragers that enabled the transition to agriculture. It precedes the recent shift towards placing greater emphasis on the role of Mesolithic populations in Europe and their incorporation of farming techniques as a mode of transition to agriculture (*Barker 1985; Dennell 1984; 1985; Hodder 1990; Thorpe 1996; Zvelebil 1996a; 1996b*). As Barker (*1997*) noted, what was heresy in the academic core in the early 1980s has become orthodoxy in 1990s and in this new development the role of population movement has been underplayed. In light of this shift in direction, the appreciation of incipient indigenous cultivation and domestication that was proposed for Lepenski Vir by Srejović fails to be as unlikely as it was back in 1972 when it was first published in English (*Srejović 1972*).

It is important to note here that, although the positions discussed above propose models for Europe as a whole, or imply continent wide implications in their titles, most of the studies of the spread of agriculture are based on the evaluation of the spread of the LBK culture limited to Central and West-Central Europe and, in terms of European periodisation (Tab. 1), contemporaneous with the Late Neolithic cultures of the Southeast: Vinča-Tordoš and Dimini (*Demoule 1988; Garašanin 1980a; 1980b; Lichardus and Lichardus-Itten 1985*). The spread of "Cardium-impresso" ceramics in the circum-Mediterranean region, with little evidence of agriculture but with even earlier pre-pottery evidence for domestic *Caprinidae* (*Batović 1966; Benac 1979; Donahue 1992; Lichardus and Lichardus-Itten 1985*), or "La Hoguette" pottery in the South-Western and Western Europe for which an African - more specifically Central and Eastern Saharan - origin was recently proposed (*Winiger 1998*), contradict the above model.

The evidence provided by southeastern Europe, and the Balkans in particular, is rarely discussed in the theoretical literature or syntheses except for absolute dates that are used to argue the direction and pace of migration or spread of cultural influence. The explanation for the neglect of patterns of interaction and change in these "marginal" European regions is mostly due to searching for a "general processual model" so typical of 1960s, 1970s and even 1980s (*as pointed out by Harris 1996c*) to which these regions do not provide a good fit, but also to the fact that the majority of data are published within local research traditions even when they are published in English. "Indigenous archaeology" (*Evans and Rasson 1984*) which has a long tradition in Balkans, is perceived as devoted exclusively to typological studies and as lacking the more sophisticated economic perspective and scientific approach of the "New archaeology". With the demise of the New archaeology in Anglo-American archaeology, that was rejected by Balkan researchers because of its apparent mechanicism (*Garašanin 1996*), "indigenous archaeology" has gained new importance for non-local archaeologists. This is apparent in the work of authors such as G. Barker and J. Chapman who not only use available data from the published reports but also discuss and sometimes incorporate the ideas and interpretations of local researchers.

In conclusion to this section, we can state that replacement is not demonstrated, although it is neither impossible nor improbable, and that the change in subsistence practices was not as uniform as previously believed. As pointed out by Van Gijn and Zvelebil (*1997.3*), "both the Mesolithic and the Neolithic were internally far more heterogeneous than we have recognised." The long coexistence of farming and foraging communities, that has been demonstrated or proposed for different regions in Europe, provides the general framework for this study. However, the cultural and biological identity of farmers needs to be examined on a regional basis. Based on archaeological evidence, we cannot assume that the same population was responsible for the neolithisation of the Balkans as for the neolithisation of the Circum-Mediterranean, Central European, or Baltic regions, nor can we argue that modes of interactions between these populations would have been the same over the entire continent. Therefore, building meaningful continent-wide models has to repose on well documented regional occurrences.

Further, comparisons between regions should be made on the basis of archaeological sequences and data, rather than testing preconceived models on local data, as there is an incipient tendency in the latter to search for adequate data in local manifestations that would fit the (usually) monocausal model (as is the case with Cavalli-Sforza's argument). This however, does not mean that comparisons and general models are not possible or meaningful. On the contrary, they become possible when the same level of insight is obtained for different regions and periods. The process of learning about the past, although embedded in the present, has to overcome this determinism, and rather then being unilinear, rooted in either local data or global theories, must incorporate both in order to transcend the present and reveal more about past than it does about our current agendas, which are implicit in Shanks and Tilley's (*1987*) approach (*see also a critique by Van Gijn and Zvelebil 1997*). In that respect, some basic premises of this work are:

- Understanding the processes of neolithisation for each region must incorporate understanding of the Mesolithic substrate and its response to (among other factors): availability of agricultural knowledge or contact with agricultural settlements.
- Responses of past foragers to contact with farming were determined by both economic and ideological strength of the local Mesolithic culture. In any of the regions they could have taken a number of forms that were not necessarily paralleled in other regions. Further, the mode of contact need not (or was even unlikely to) have remained the same over long periods of time in which these different forms of subsistence were practised by respective populations.
- Introduction of material and symbolic (as much as we can perceive them) elements of one culture into the other, if they did not substantially change the subsistence base, can only be used as evidence for contact and not as evidence for acculturation.
- Regardless of the ultimate origin of agriculture, the farming community with which local Mesolithic inhabitants were coming into contact, could have been at the time: of different geographic origin or of the same geographic origin.
- This population in either of the above cases could have been: morphologically and/or genetically distinguishable or morphologically and/or genetically indistinguishable.

2.5. The choice of study area

The first manifestations of the Neolithic in Southeastern Europe and the Balkans precede the LBK culture and show significantly different economic, social and ideological patterns (*Benac 1979; Garašanin 1979; Srejović 1979*). Three major complexes are distinguished within the Neolithic of Southeastern Europe. Each covers relatively vast geographic areas and includes groups that are more or less related. These are the Balkano-Anatolian complex of the Early Neolithic, the Balkano-Karpathian complex and the Occidental Mediterranean complex (*Garašanin 1980*). The Balkano-Anatolian complex includes (in the European part) Thessaly, South-East and South of the Balkan Peninsula (Thracia south of Stara Planina and Macedonia), as well as an important enclave that spreads north into the Pannonian plain and the Karpathians. It includes groups defined as Protosesklo in Thessaly, Anzabegovo Vršnik I in Macedonia, Karanovo I in Thrace and Gura Baciului in the Karpathian basin (*Garašanin 1980.58*). Although based primarily on the typological and stylistic analysis of ceramic production and habitation, it coincides with economic parameters. The major distinction between the Balkano-Anatolian and Balkano-Karpathian complex is that goat/sheep herding predominates in Thessaly (*Bökönyi 1974; Barker 1985. 63*), while cattle are characteristic of Starčevo-Criş-Körös farmers (*Bökönyi 1974*). Bökönyi argues for local domestication of cattle in Argissa Magula (*Milojčić et al. 1962*) and Nea Nikomedeia (*Higgs 1962*) that was soon replaced by animal husbandry based on caprovines, and that gave rise to the Starčevo-Criş-Körös complex of the Early and Middle Neolithic. Unfortunately no faunal data are published for Gura Baciului, and the fauna of the closest related settlement (that of Lepenski Vir III) is published without regards to LV IIIa being synchronous with Early Neolithic (Gura-Baciului, Thessalian tradition) and LV IIIb with Middle Neolithic, classical Starčevo. In the Lepenski Vir III settlement wild animals predominate (74,5%) while bovines are most common among the domesticates (15,83%) (*Bökönyi 1972*). Goat/sheep remains follow and are also attested at the Mesolithic site of Padina although their exact provenience is not clear (*Clason 1980*). Also, the fact that in the Balkans there is a paradoxical absence of palynological and other evidence for agricultural impact on the landscapes until c. 4000 BC (*Willis and Bennet 1994*), points to a different scale and importance of agriculture in this period than for the Late Neolithic Dimini-Vinča-LBK agriculture.

The fact that new cultigens and (some) domestic animals are introduced to Southeast Europe together with the spread of ceramic and polished stone axes can be conveniently used as a sign of a moving agricultural frontier. The question is how to perceive and study this frontier, and the interactions that "Mesolithic foragers" and "Neolithic farmers" could have had. Dennell states that from 5300 to 4300 BC there was a rapid expansion of agriculture by pottery-using communities living in "large, permanent settlements" across much of Southeast and Central Europe. "Thereafter, agricultural expansion into northern and western Europe was more gradual and seldom associated with large, year-round settlements until much later." (*Dennell 1985.121*).

What he refers to as "large, permanent settlements" are "tells" such as Anzabegovo (*Garašanin 1974a; 1979; Garašanin and Garašanin 1961; Gimbutas 1976*), Karanovo, (*Georgiev and Čičkova 1981*), or Argissa Magula (*Milojčić et al. 1962*) that could have resulted from non-permanent but repeated use (*see also Bailey 1997*). Starčevo I (Early Neolithic) and Starčevo II (Middle Neolithic) settlements that characterise the Central Balkans present a different picture both in terms of architecture and spatial organisation. They do not have the complex vertical stratigraphy of the "magulas" or "tells" and were most probably not re-occupied after being abandoned. Permanent occupation of both types of sites is questionable, since the extensive (shifting) agricultural practices require that new land is found whenever the one currently being used becomes too poor in minerals and necessary elements and therefore requires either enlarging the radius of exploitation (with rising cost of transport and protection of the crops) or moving a settlement. The latter seems to be characteristic of both the Anzabegovo and Starčevo types of settlements. Only with the Vinča intensive agriculture (*Garašanin 1979*) and LBK introduction of crop rotation (*Willerding 1980*) does it become possible to have permanent settlements.

Dennell's (*1985*) appreciation of size and permanence (and associated mobility) of different groups in Balkans prehistory, leads him to assume that hunter-gatherers would perceive the agriculutralists as having "more substantial houses, novel items such as pottery, polished stones and so forth" and would therefore be more inclined to observe them as "better off", which would result in hypergyny and a loss of the Mesolithic population to incoming farming groups. Although this model does not fit all the archaeological data of the region (especially in terms of permanence of the Early Neolithic settlement and perception of farmers by foragers), determining the frontier for the interactions of early farmers and local foragers as porous, allowing transfer of people, resources and techniques across the border, seems appropriate in at least some of the early interactions and has been a crucial breakthrough in our understanding of forager-farmer interactions (*Zvelebil 1996a and quoted literature*). Since hunter-gatherers would have a larger radius of movement, they would more often come in contact with local farmers near the latter's villages, and could thus appropriate their knowledge and techniques, or be appropriated (one way or another) by farmers.

2.6. Why Mesolithic population of the Iron Gates Gorge?

Both the Epipaleolithic and Mesolithic of the Balkans, with the exception of the Iron Gates Gorge and some smaller sites in Montenegro and eastern Serbia, are understudied. However, the Iron Gates Gorge has been excavated extensively and has produced evidence for all of the Mesolithic economy and structure (as discussed above). The sites in the area offer a unique possibility to observe possible (and probable) interactions between foragers and farmers over a substantial time span. These interactions can be further traced in the skeletal record and potentially some of the biological features of them could be delineated. Ideally, we would have as large a collection of Neolithic sample from the region, but it is not the case. We could lump all of the osteological material from early and middle Neolithic of the Balkans together, but this could cause the general trends of the region to obscure the specifics of interaction and therefore, a more regionally restricted approach was deemed better. With the stated problems in mind, the region was chosen for several reasons:

- The neolithisation of this area preceded the neolithisation of all other parts of Europe except the Aegean.
- The extent of excavations on a number of sites on both banks of the Danube has been unparalleled in the last three decades as they have exposed substantial living surfaces amenable to detailed archaeological analyses.
- Through abundant architectural features, artefacts, faunal, plant and osteological remains, the sites provide insight into both cultural and populational consequences of contact.
- Since the archaeological coexistence of the Mesolithic Schela Cladovei-Lepenski Vir culture and Neolithic Starčevo culture has been established (*Bonsall et al. 1997; Boroneanţ et al. 1995; Radovanović 1992; 1994; 1996a; 1996b; 1996c*) the degree and mode of interaction between the bearers of these cultures can potentially be traced in human osteological remains.
- Since this is one of the largest Mesolithic skeletal samples in Europe, information provided by skeletal data can be crucial in our understanding of the resulting biological change in the population under transition and potentially elucidate its causes.

2.7. Questions

This research attempts to reconstruct the extent of interactions between farmers and foragers through examining two aspects of skeletal material from four of the most important sites excavated in the region: Lepenski Vir, Hajdučka Vodenica, Vlasac and Padina. Here I propose a list of questions that this work will attempt to answer. The choice of material, theoretical premises and methods, are discussed in subsequent Chapters (3 and 4). The results of the analyses are presented and discussed in Chapter 5 and a discussion and conclusion offered in Chapter 6 and 7 respectively.

1st question: In light of a proposed porous frontier between Mesolithic and Neolithic cultures in the studied region, traceable in the archaeological evidence, can we presume the interactions between bearers of these respective cultures?

2nd question: If there was an interaction between foragers and farmers, are we able to perceive it through the study of anthropological material?

3rd question: If the spread of agriculture was a consequence of cultural transfer alone, is it likely that the biological profile of the population will change significantly? In which direction?

4th question: If the Early Neolithic population of the Balkans is different from the Iron Gates Gorge Mesolithic population, can we trace the effects of contact on the latter?

5th question: If we can argue for a change in the Iron Gates population as a result of contact with Neolithic population WHEN did this change occur? Did it happen at the time of the first contact, which did not bring about the change in subsistence, or later, when the subsistence changes sufficiently to determine Iron Gates sites as Neolithic?

6th question: In either case, what explanation can we propose for the change: genetic admixture, replacement or changing ecology (occupation/nutrition)?

3. THE LEPENSKI VIR CULTURE

This chapter is an attempt to summarise the archaeology of the Mesolithic to Neolithic transition in the Iron Gates Gorge, through some of its major features. In keeping with the goal of examining the possible biological (populational) effects of contact of Mesolithic foragers with Neolithic farmers, the chronology and the evidence of contact in the archaeological record were examined. The four sites from the right bank of the Danube are presented together with details of chronological assessment of each of the skeletons within the sites. Because of the fact that the Mesolithic component is present on all four of the sites, while Neolithic (as defined earlier) could be ascertained only at Lepenski Vir, these interactions are examined from the Mesolithic perspective. Accordingly, considerable space is allocated to the description of the basic features of the Iron Gates Gorge Mesolithic. The Neolithic component at the Lepenski Vir site fits well within the Balkano-Karpathian complex as described by Garašanin (*1979*). Therefore, it will only be discussed briefly in reference to pottery as the most prominent evidence of the contact at the sites. After the examination of the proposed methodology (Ch. 4) and the presentation of the results (Ch. 5), discussion on the morphological and biological affinities of each of the examined populations is proposed in Chapter 6.

3.1. Research, publications and interpretation history

As recently as 1950 the Central Balkan was deemed to be uninhabited during the Mesolithic period (*Srejović 1989*). The surveys and excavations that were undertaken before the building of the dam on the Danube downstream from the Iron Gates Gorge during the 1960s unearthed a number of Holocene sites in the Gorge that were ultimately assigned to the Lepenski Vir-Schela Cladovei cultural group. On the Yugoslav bank of the Danube (Fig. 3), Padina (*Jovanović 1972; 1974*), Stubica, (*Jovanović 1971; 1974*), Lepenski Vir (*Srejović 1968; 1969; 1971; 1979; Srejović and Babović 1983*), Vlasac (*Srejović and Letica 1978*), Hajdučka Vodenica (*Jovanović 1984a*), Velesnica (*Vasić 1986b*), and Kula (*Sladić 1986*) were excavated over a 20 year period. On the Romanian bank of the Danube, Privod, Alibeg, Ilisova, Razvrata, Ostrovul Banului, Schela Cladovei, (*Boroneanţ 1973*) Vodneac, Cuina Turcului (*Boroneanţ n.d.),* Climente I and II, (*Boroneanţ n.d.; Radovanović 1981*), Veterani terrace, Icoana, Ostrovul Corbului (*Mogosanu 1978*), Ostrovul Mare 875, and 873 (*Boroneanţ 1980*) were excavated in successive campaigns from 1964 to 1973.

From the 1970s onwards, a number of important volumes appeared: an English language compilation of the known data by Tringham (*1971*), a monograph on Vlasac by Srejović and Letica (*1978*), the Cuina Turcului final report (*Paunescu 1978*), the papers from the conferences on the problems of neolithization held in Sarajevo in 1977 and Krakow 1979 (*Benac 1978; 1980; Garašanin 1978; Srejović 1978; 1980; Mikić 1980; Kozłowski and Kozłowski 1978*), the conferences on the Mesolithic in Potsdam, Edinburgh (*Boroneanţ 1989; Srejović 1989; Voytek and Tringham 1989; Chapman 1989*), Grenoble 1995 (*Radovanović 1995; Boroneanţ et al. 1995*), and conferences on the Mesolithic and the chipped stone industries of the earliest farmers at Krakow (*Kozłowski 1982; Kozłowski and Kozłowski 1987; Paunescu 1987*). As well, a number of analyses were published on the chipped stone industry: from Padina (*Radovanović 1981*), Vlasac (*Prinz 1987*), and Lepenski Vir (*Kozłowski and Machnik 1980*) as well as on floral and faunal remains (*Clason 1980*). Syntheses also appeared at the time: in *Praistorija Jugoslovenskih Zemalja* [Prehistory of Yugoslavia] by Srejović, Benac and Garašanin (*1979*), then in *Esquisse d'une Préhistoire de la Romanie* (*Mogosanu 1983; Dumitrescu et al. 1983*), followed

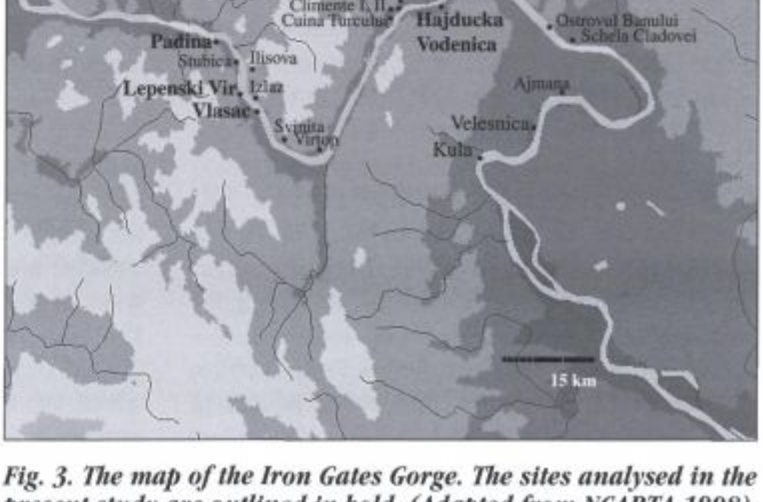


Fig. 3. The map of the Iron Gates Gorge. The sites analysed in the present study are outlined in bold. (Adapted from NCARTA 1998).

by a synthesis on Banat in the Neolithic by Lazarovici (*1979*). Lepenski Vir was briefly discussed in *La Protohistoire de L'Europe* (*Lichardus et al. 1985*), as well as in *Domestication of Europe* (*Hodder 1990*), in *Europe in the Neolithic* (*Whittle 1996*), and in a number of articles by Chapman (*Chapman 1989; Chapman and Dolukhanov 1993*).

Radovanović provides an excellent historical and critical overview of the phases of research and publications in the region (*1996a.2–10*). The monograph by Radovanović is the first synthesis based on published works, field documentation and a new approach to a combination of stylistic, chronological, and material analysis for the entire region. While she draws heavily from all local resources available, Radovanović manages to incorporate a new understanding of a variety of issues into her appreciation of the data collected in the field. Benefiting from firm knowledge of the regional archaeology, access to field documentation, as well as a wide array of theoretical perspectives, the volume successfully incorporates different intellectual traditions into a comprehensive study. More importantly, this volume provides a wealth of information on particulars of the regional Mesolithic so often lacking in theoretical discussions by non-local scholars.

A number of analyses that appeared in the 1980's on chipped stone assemblages from Lepenski Vir, Vlasac and Padina established continuity between the Iron Gates Epipaleolithic and Mesolithic. However, different synchronisations among phases of the sites were proposed (*Radovanović 1996a.9 and quoted literature*). Late Palaeolithic finds from Cuina Turcului I were perceived as predecessors of the Lepenski Vir culture by Srejović (*1989.54*) and he offered the following periodisation:

① Late Palaeolithic, (Cuina Turcului I);
② Epipaleolithic (Cuina Turcului II, Ostrovul Banului I–II);
③ Early Mesolithic (Icoana I, Ostrovul Banului IIIa, Schela Cladovei I, Padina A, Vlasac Ia, Proto-Lepenski Vir);
④ Late Mesolithic (Icoana II, Ostrovul Banului IIIb, Schela Cladovei II, Padina B1, Vlasac II–III, Hajdučka Vodenica, Lepenski Vir I–II);
⑤ Mesolithic/Neolithic (Padina B2, Kula, Alibeg, Ostrovul Mare) and
⑥ Early Neolithic – the formation of Proto-Starčevo (Lepenski Vir IIIa, Cuina Turcului III, Padina B3).

Boroneanţ (*1989*) supported the appreciation of continuity from the Late Palaeolithic, through the Epipalaeolithic (Clissourien-Romanellien and Schela Cladovei) and into the Mesolithic Lepenski Vir culture until the Middle Neolithic. The process of neolithisation is regarded as a local development by both of these authors although their interpretations differed in details.

A different opinion is presented by Paunescu (*1978*) who perceives the Neolithic culture of Starčevo-Criş (Middle Neolithic) type as an immigrant population that interrupted the local isolated development of the Schela-Cladovei hunter-gatherer-fisher group. He also maintained that an earlier Neolithic population (Early Neolithic of Proto-Sesklo, Anzabegovo, Donje Branjevine, Gura Baciului type) was contemporaneous and in contact with Schela Cladovei (*Paunescu 1987*). Unfortunately this argument is not discussed in relation to the sites on the right bank of the Danube and only Lepenski Vir III is incorporated and attributed to the classic phase of Starčevo Culture *contra* Srejović who makes a distinction between IIIa and IIIb in which the IIIa would be Early or Proto-Starčevo (*Srejović 1969*).

For Lichardus-Itten (*1985*), the contemporaneity of the Starčevo and Lepenski Vir cultures completely excludes the possibility of local neolithisation. Jovanović (*1987.14–15*) has maintained that all three settlements of Padina B phase belong to the Starčevo-Criş complex based on *in situ* finds of Starčevo ceramics in Lepenski Vir type houses. Voytek and Tringham (*1989.494–495*), who propose extensive social contacts between these two subsistence systems, argued for their coexistence.

While most of the authors agree that the origin of the Schela Cladovei-Lepenski Vir complex should be looked for in the local Late Palaeolithic, their disagreements range both in the timing and mode of transition from the Mesolithic Lepenski Vir to the Neolithic Starčevo culture, as evidenced by the Middle Neolithic Starčevo horizon in Lepenski Vir IIIb. Drawing on analysis of the chipped stone industry and her revaluation of the typological and chronological associations from the sites on the right bank of the Danube, Radovanović (*1996a.313*) accepts that certain elements of the Iron Gates Mesolithic tool kit were related to the preceding Epipaleolithic period. The VIII[th] millennium BC witnessed the change in the mobility pattern of local hunter-gatherer groups, which led to more permanent settlements. Three groups (at least) can be distinguished in the local Mesolithic community. The (1) Upper Gorge group, (2) the Ključ area group that split from the first one and (3) the Lower Gorge group(s). All groups are characterised by a hunting-gathering-fishing economy, similar settlement and burial practices, and distinguished by their preferences in hunting, different architectural and burial elements, as well as details of stone industry (*Radovanović 1995; 1996a; 1996c*).

The Mesolithic economy of the Lepenski Vir culture is of long duration, from the second half of the VIII[th] to the first half of the VIth millennium or perhaps even until the V[th] millennium - already characterised by late Neolithic Early Vinča culture in the region (*Radovanović 1995*). Contacts with the Neolithic population were possible from the mid VII[th] millennium (Donje Branjevine, Gura Baciului). However, there is no change in subsistence until the fully Neolithic (Middle Neolithic) Starčevo settlement Lepenski Vir IIIb, and a Starčevo settlement in the vicinity of Padina sector IV (*Jovanović pers. comm.*), where food production and imported domesticates (sheep/goat) are attested. Radovanović places contact with groups using pottery (Starčevo Neolithic groups) in her phase 6 (see later in the discussion of chronology) while pottery sporadically appears from phase 4. The meaning of this intrusion has been discussed in the literature, from taphonomic effects of site formation (*Srejović pers. comm.*) to local architectural development within the Starčevo complex (*Jovanović 1987*).

Ranging from local continuity to brisk interruption by incoming farmers, the Mesolithic/Neolithic transition of the Iron Gates Gorge offers an array of possible interpretations. In the view of likely interactions between two subsistence systems that changed over time, the chronology (Ch. 3.3), and individual sites with details of their archaeological features, as well as detailed chronological determination for each of the individuals (Ch. 3.4) are presented.

3.2. Natural setting and basic archaeological data

Once the Danube leaves the fertile Pannonian plain and cuts its way through the Karpathian massif, the vast mass of water that measures more than 5 km from one bank to the other enters a bottleneck that measures ten times less (Fig. 1). Before the building of the dam for the hydroelectric plant, navigation in the Gorge was very difficult in winter and spring. In geological terms it is dominated by limestone massifs with typical karstic traits, but also siliceous bedrock in the valley-like parts of the Gorge. The presence of limestone bedrock on siliceous bedrock (these are not however, the only formations) influences the great variability in soil types (*Misić 1981, quoted in Radovanović 1996a*). The differences in vegetation types, caused by subsoil and soil types, between the canyon-like and the valley-like parts is great. In the vicinity of Lepenski Vir and Vlasac (Gospodjin Vir) alone, there are 20 types of forest and scrub associations. The climate is different from the surrounding regions with more rainfall, lower summer, and higher winter temperatures. It also differs between regions of the Gorge. It is dryer in the canyon-like parts, with more rainfall in the valleys.

During the Pleistocene, the specific geomorphology of the Gorge played an important role in reducing climatic oscillations, which is evident in an important number of relict Tertiary species found in the Gorge, especially in the lower altitudes. Together with considerable precipitation, this was the major factor in quick forest regeneration in Pleistocne (*Cvijić 1987/1922; Mišić 1981; Radovanović 1996a*). With the Early Holocene (Preboreal and Boreal) the difference between the Iron Gates Gorge and the surrounding areas diminish.

Pollen remains were collected on only two of the four sites: Lepenski Vir (*Gigov 1969*) and Vlasac (*Carciumaru 1978*), and only a portion of them has been analysed. On the Romanian side, palynological data are available for Icoana (*Carciumaru 1973*), and the most comprehensive sequence is provided by the site of Cuina Turcului (*Pop et al. 1970*). Carciumaru argues for the appearance of Cerealia type pollen grains in Vlasac II, and an increase in size and importance of the Cerealia type grains in the Boreal and in the beginning of the Atlantic at Icoana. Their size increases in the upper parts of the section. In comparison their appearance is earlier than at Vlasac.

Animal remains are very diversified at all sites. However, some species predominate. As mentioned earlier, even with the introduction of a Neolithic economy, hunting and fishing remain important on the sites. New studies of the animal bone material are under way for all four sites, as some of the problems (seasonality for example) were not adequately treated in previous research (*Dimitrijević pers. comm.*). A more serious problem is that most of the analyses treat sites as units, regardless of the stratigraphy (*Bökönyi 1969; 1978; Greenfield 1984*) except for Padina (*Clason 1980*) where the stratigraphy was respected. However, it was possible in most of the cases to reconstruct the provenience and arrive at relative representations of species per period for most of the sites (*Radovanović 1996a.52–59*) and reconstruct the importance of different species per period. A long overdue refined analysis, recently undertaken by Dimitrijević (*pers. comm.*), takes into account the context, and promises more comprehensive conclusions. Radovanović proposes the following picture of hunting practices in the Gorge:

> Red deer, ibex, wild pig and aurochs are among the most important wild species in all periods. In the Epipaleolithic, the difference between sites is based on the site-type. In the Mesolithic the situation changes. The dominant hunting species on the right bank of the Danube is red deer, while wild pig seems to be extremely important on the left bank (unfortunately data are known only for Icoana). Hajdučka Vodenica, across from Icoana, also has high proportions of wild pig. It seems that its importance was higher in the Lower Gorge. Although red deer is less frequent among faunal remains in the Neolithic period, it remains the most important hunted animal. It is also worth noting that wild ass is hunted not only at Padina B and Lepenski Vir III but also at a number of Pannonian Körös and Starčevo sites (*Lazić 1988. 24–27; Radovanović 1996a.55*).

Fishing, as already pointed out earlier, played an important role in the Mesolithic Iron Gates subsistence. But, just how important, remains an open question. The main fishing season coincided with migration of the red deer to higher altitudes and could have been instrumental in establishing camps on the river bank in greater numbers than previously. This difference would arise from the Black Sea transgression and the rise in water temperature that caused the growth of shoals of local and anadromous fish (*Radovanović 1996a.55 and quoted literature*). The data collected on a number of sites imply that fishing in the Epipaleolithic was not systematic. Fish of both low and high quality (10 species total) are noted. Throughout the Mesolithic and Neolithic the number of species fell to four, but the quality as well as quantity of any of these four species is much larger, and fish remains comprise as much as 60% of osteological remains for Vlasac and Lepenski Vir I and over 87% of bones at Padina. Hajdučka Vodenica, with its 83.33% of game and only 1.58% of fish poses some problems in interpretation (Tab. 2). Several explanations are plausible:

- The site was a highly specialised ritual site (*Jovanović pers. comm.*) and the bones reflect the prescribed food for the veneration of ancestors (evidenced by a large number of graves in the formal disposal area).
- Fishing was impractical at the site and game was more readily available.
- Along the same lines, this could have been a seasonal hunting station.
- There is an important preservational or excavational bias that acted to reduce fish remains. Although this last explanation is always a possibility, since the same team excavated both Padina and Hajdučka Vodenica and their respective percentages for fish and game are practically inverse, it seems the least likely, however preservation bias can not be ruled out.

The lack of anadromous fish (sturgeon or beluga *Huso huso* and sterlet *Acipenser ruthenus*) at Vlasac and Lepenski Vir is surprising and it points to a change in fishing practices between Epipaleolithic and Mesolithic. Clason notes that sturgeon is not found among fish remains of Starčevo and Körös period either. Its presence in Padina is, most probably, in association with the Epipaleolithic Padina A stratum. Bonsall *et al.* (*1997*) have argued that fish played not only a vital, but also the most important part of the subsistence of both Mesolithic and Neolithic people in the Gorge. The proportion of the game/fish bone coincides with the importance of the fish in the diet, although these proportions should be taken with caution due to the unequal yields as well as preservation and collection bias. However, it does not exclude other sources of protein as suggested by isotope analysis. Since the $\delta^{15}N$ values distribution is not very well understood (*Nelson pers. comm.*) and very few analyses have been done on the local fauna, especially Black sea fish, zooarchaeo-

Site/period	Game	Fish	Dog	Other domestic
Vlasac	33.48%	59.95%	6.57%	–
Lepenski Vir I	37.74%	57.31%	4.95%	–
Lepenski Vir II	62.60%	25.72%	11.60%	–
Padina A	57.13%	39.47%	2.18%	1.19%
Padina B	8.54%	87.34%	3.45%	0.65%
Hajdučka Vodenica	83.33%	1.58%	3.96%	11.11%
Lepenski Vir III	57.49%	16.88%	5.91%	19.69%

Tab. 2. Game, fish, dog and other domestic animals in the Mesolithic and Neolithic of the Iron Gates Gorge. Based on identifiable skeletal elements. (*Adapted from Radovanović 1996a.57 and Bökönyi 1969.224–225*).

logical evidence seems to bear more weight. More research into the isotope values for different foodstuffs and better sampling is needed in order to forward conclusive results, even if we accept that the method is sufficiently developed to distinguish without doubt between riverine and terrestrial resources.

The lack of anadromous fish in both the Mesolithic and Neolithic (Starčevo sites) in the region is much harder to explain and Radovanović proposes the ritual importance of anadromous fish, resulting in food taboos, as a probable explanation. Preservation bias should not be excluded from consideration since these fish are characterised by cartilaginous skeleton. However, dermal plaques preserve well and have been attested in the Epipaleolithic and Early Mesolithic strata at Padina.

The presence of domestic animals creates another issue in the debate. Dog was domesticated in the Iron Gates Gorge without doubt and is found in the Mesolithic, Transitional and Neolithic strata of Lepenski Vir, Vlasac, Padina and Hajdučka Vodenica. At Icoana selective hunting of wild pig (very young and very old animals) and possible domestication of dog point in the same direction (*Bolomey 1973*). The analyses from Padina and Hajdučka Vodenica are not as conclusive as the material, in both cases, was studied without respect to chronological units. Although many features in this table merit explanation the most important feature in this respect is the low percentage of domestic animals (other than dog) at all but Hajdučka Vodenica and Lepenski Vir III. Hajdučka Vodenica has an unlikely lack of fish bones that could account for elevated percentage of domestic animals, but when domestic animals are viewed as a sample, 52.6% of them belong to the domestic pig, 26.3% to the dog and only 7.9% of the 11.1% (less than 1% of the total sample) belong to *Bos taurus*. Since the transitional phase as well as the Mesolithic are present on the site, and while no distinction between strata is made in the faunal report, we cannot argue for the presence of Neolithic economy at the site. Incipient pig domestication plays an important role in the faunal assemblages of the Lower Gorge sites and represents a local development.

All of the other units, except for the Lepenski Vir III (Neolithic) strata present less than 5% of domestic animals which coincides with Zvelebil's (*1996a*) explanation of a porous agricultural frontier, and serves more as evidence of contact (trade or raiding) rather than of a Neolithic economy. A high proportion of wild animals and fish in Lepenski Vir III points to a strong local tradition among the Early and Middle Neolithic settlers of the site, or to the possibility that Lepenski Vir was an atypical Neolithic site, a non sedentary station for hunting and gathering. Either way, the knowledge of the region and the know-how of the Mesolithic hunters were already acquired. Again, it would be of great value to be able to distinguish between Early LV IIIa and Middle LV IIIb Neolithic settlements as the relative importance of *Ovis/Capra* and *Bos taurus* are expected to have changed in the region from one subperiod to the other.

Bonsall *et al.* (*1997.56–57*) argue that preservation bias could have played a role in the lack of domestic animals in Lepenski Vir I and II which both Chapman and Whittle (*1996*) consider to be synchronous with Neolithic Starčevo. Although faunal analyses by Bökönyi, performed within the framework of the 60s and 70s are lacking in detail (*see Lyman 1994, for new approaches to MNI and skeletal elements proportions*), they are consistent throughout the Iron Gates material. Therefore, it would be hard to argue for preservational bias regarding domesticated animals in LV I–II if no such bias is observed in LV III strata. Very restricted numbers of identifiable specimens in LV I–II (less than 500) compared to LV III (over 2000) could account for some bias in species representation, but not for the total lack of selected exploited species. If sieving can account for a greater share of fish bones in recent excavations at Schela Cladovei, there is no reason to suppose that the overall proportions of mammal skeletons would be significantly altered.

Mesolithic settlements are exclusively open-air sites, usually on the small terraces along the Danube, or on islets in the river. They seem to cluster in favourable areas, and although their distribution, as we know it, could have resulted from the surveying constraints, it is more likely that certain regions, marshy and uninhabitable today (like the estuary of the Porečka River), were the same in the Mesolithic. The size of settlements is variable, determined by the available space which also plays one of the crucial roles in the spatial organisation (*Radovanović 1996a.65*). However, the number of houses would be more strongly influenced by the number of inhabitants and the type of their social organisation, than by the available space. Therefore, Radovanović (*1996a*) suggests that the number of houses within each time slice had to be lower than proposed by authors who have investigated the settlements (*Jovanović 1987; Srejović 1972*).

Architectural structures of Lepenski Vir culture are reported only on the right bank of the Danube. The major theme is trapezoidal house floors that resemble in their outline the hill of Treskavica situated across from the site of Lepenski Vir. This dominant rock formation, bereft of vegetation in its upper parts, still looks impressive from the water line and is the reasonable prototype for the house outlines (*Srejović 1969*). They are not the only type of habitation. Radovanović (*1996a*) distinguishes the following:

① dugouts (Vlasac),
② semi-dugouts with oval base and circular hearth (Ostrovul Corbului),
③ semi-dugouts with oval base and rectangular hearths (Proto Lepenski Vir),
④ semi-dugouts with trapeze-like shape and ellipsoidal hearth beside them (Vlasac I),
⑤ semi-dugouts with trapezoid shape and rectangular hearth in the open or within the house (Padina B, Lepenski Vir I, Vlasac Ia–b),
⑥ above ground habitations with trapezoid shape and rectangular hearths (Padina B, Lepenski Vir II, Kula I),
⑦ above ground habitations with circular base and rectangular hearths in the open air (Vlasac II–III, Hajdučka Vodenica I, Kula I), and
⑧ above ground rectangular habitations with rectangular hearths within or in the open (Vlasac III, Hajdučka Vodenica I).

The canonised measurements (*Srejović and Babović 1983.44–45*), sophisticated outline of these dwellings and associated sculptures and ritual objects, have led to different interpretations of their meaning, ranging from houses, ancestral shrines (*Chapman 1993; Whittle 1996*), ancestral and river deity shrines (*Srejović 1969; Srejović and Babović 1983*) and solar shrines (*Babović 1998*).

The most prominent and chronologically sensitive features of the architecture of the Lepenski Vir-Schela Cladovei culture are the hearths. The chronology based on the stylistic analysis of the hearths compared with superimposed (slightly displaced towards the slope) house floors at the site of Lepenski Vir has matched the data for superimposed houses at Padina, and thus provided a basis for the chronological comparisons between sites as well as regional differences between the Upper and Lower Gorge (*Radovanović 1996a*). All domestic and/or ritual activities seem to have been centred around the hearths and their association with graves was important at all sites, nowhere more than at the site of Hajdučka Vodenica (Fig. 13). Synchronisation of the houses for Lepenski Vir I subphases proposed by I. Radovanović (*1996a*) differ considerably from those proposed by Srejović and imply different social organisation, as well as different forces behind these processes. While Srejović argues for ever increasing competition between two "clans" within the Lepenski Vir settlement (*1969.57*), Radovanović proposes that as early as Lepenski Vir I (2), her phase of consolidation and symmetry, the Mesolithic population comes in contact with the Neolithic population. This results in more centralised, more canonised and more cohesive picture of the settlement as a reflection of stronger ideological integration.

The essential raw materials for chipped stone industries during the Epipaleolithic and Mesolithic were of local origin. A small percentage of non-local obsidian (from the Tokay Presov region) in the Epipaleolithic points to spatially large (but small volume) exchange networks in which the Iron Gates population participated. A more significant role of exchange can be confirmed in the post contact period at Lepenski Vir I, Padina B1–B3 at Sector III and the horizon with rectangular hearths in Sector II, and Hajdučka Vodenica, based on the importance of the Pre-Balkan Plateau flint. For the finds of this type of flint at Vlasac III, Kozłowski and Kozłowski (*1987*) propose taphonomic explanations. This flint variety is the most prominent raw material in the Early and Middle Neolithic of Oltenia, Banat and Transylvania, as well as at the majority of the Körös sites in Hungary (*Radovanović 1996a.231–235 and quoted literature*). In terms of chipped stone industry, local tradition seems to be very important throughout the Mesolithic and well into the Neolithic (*Radovanović 1995*). One important difference is the increase in retouched blades and decrease in geometric microliths at Lepenski Vir III a–b, Cuina Turcului III and to a lesser extent at Vlasac III. Radovanović (*1996a. 250, Fig. 5.16*) distinguishes four chrono-typological units based on the relative frequencies of scrapers, retouched flakes and retouched blades. The Epipaleolithic industries (first group) are characterised by a high percentage of endscrapers, increase in retouched flakes and disappearance of retouched blades. The second group (the Lower Gorge) is characterised by a high percentage of retouched flakes and an increase in retouched blades. The third group contains industries with a trend towards a further decrease in the proportions of endscrapers, a decrease in retouched flakes, an increase in retouched blades. The fourth group represents Neolithic industries with a high percent of retouched blades. The data provided by the chipped stone industry argue for a strong local continuity. All of the sites with formal disposal areas fall neatly within the third group: Vlasac I–III, Lepenski Vir I–II, Schela Cladovei I–II, Hajdučka Vodenica I, Kula I–II, while the fourth group is represented by sites with either a Neolithic component or strong Neolithic influence: Padina B, Lepenski Vir IIIa–b, Kula III, Hajdučka Vodenica II, Cuina Turcului III–1/3. It is important to note the significant overlap in absolute chronology between industries of group III (7200–5300 BC) and group IV (6100–5200 BC).

Pottery, long held as a tell-tale sign of the introduction of the Neolithic to Europe, appears in many of the sites within the Iron Gates Gorge and has been a major source of discussions between Srejović, Jovanović, Boroneanţ and many non-local researchers. On the left bank of the Danube, pottery is associated mostly with well defined sites of the developed phase of the Starčevo-Criş (middle Neolithic) complex, except in the case of Schela Cladovei, where a "Proto-Sesklo" hut was dug into the Mesolithic layer (*Boroneanţ 1989.479*).

On the left bank the Neolithic habitations, when superimposed on local Mesolithic settlements with particular habitations, hearths, and chipped stone industry, are all clearly divided stratigraphically. On the right bank the situation is reasonably clear in the Lower Gorge, Ključ and downstream from Ključ (Hajdučka Vodenica, Kula, Velesnica). The most problematic is the situation of Lepenski Vir and Padina, both of which are situated in the Upper Gorge (*Radovanović 1996a.282*). Since both sites have complex vertical and horizontal stratigraphy and evidence of other imported material, but no evidence of change in the economic structure and ideological world of the local inhabitants, the appearance of pottery is recognised as evidence of contact between local foragers and pottery bearing Neolithic farmers. Pottery appears in all horizons of Padina B at all sectors, while there is no evidence of its appearance in Padina A, or A/B. Similarly, Proto-Lepenski Vir and Lepenski Vir Ia–b (Radovanović's phase I–1) did not contain pottery, while it starts appearing in Lepenski Vir Ic–e (*Srejović 1969*), or Radovanović's phase I–2 and I–3. Lepenski Vir II did not contain any pottery, and it appears again with the Neolithic economy of Lepenski Vir IIIa and IIIb. Vlasac I–III, akin to the Lower Gorge settlements, did not contain any pottery until fully Neolithic Vlasac IV stratum. The appearance of pottery coincides with the distribution of the pre-Balkan Plateau flint, and argues for greater importance of trade.

While assuming that pottery is necessarily a Neolithic invention throughout Europe is inherently problematic, there is no reasonable doubt that pottery was brought into the Iron Gates Gorge Mesolithic communities by surrounding Neolithic people since it fits well within the Gura Baciului and Starčevo tradition (*Jovanović 1984a; 1987*). In terms of newly proposed periodisation by Tasić (*1997; 1998*), the ceramics found at the sites of Lepenski Vir and Padina fall well within the Early and Middle Neolithic of Central Balkans with no particular developments that would suggest local invention. Early Padina ceramics correspond to the ENCB phase (*Tasić 1997. 125*), which is consistent with assignment of Lepenski Vir IIIa (Srejović's Proto Starčevo) into the MNCB I and Lepenski Vir IIIb (Classical Starčevo) into the MNCB II phase. However, since the absolute dates from Lepenski Vir are much later than would be expected, and the ceramics have not been published, Tasić refrains from firm assignation noting that the published material would fit in his MNCB II phase.

Sporadic appearance of the ENCB type ceramic in the pre-Neolithic layers at Lepenski Vir and Padina would not necessarily represent imported goods, and could well be local production within the tradition of the Neolithic of the Central Balkans. Therefore, the appearance of pottery on these sites can serve as a marker of the contact between farmers and foragers, independent of absolute chronology and uncertainties of ^{14}C dates and will therefore be discussed further in the chronology section. The rationale behind the use of pottery as an independent marker of contact is found in its non-local origin that supposes either trade, transfer of knowledge, or transfer of people with this particular knowledge into the Iron Gates Gorge communities. All of these imply the availability of contact, even where there is no firm evidence of contact itself.

3.3. Chronology

"The absolute chronology of the Lepenski Vir culture is impossible to establish on the basis of comparative historical methodology, as throughout its long existence it remains entirely isolated, devoid of any contact with the outer world" wrote Srejović (*1969. 41*). The subsequent unearthing of a number of sites on both the left and right banks of Danube in the

Iron Gates Gorge itself and in at least two localities downstream from the region of Ključ (Velesnica, Kula) made it apparent that, although isolated, the Lepenski Vir culture has its predecessors in the Schela Cladovei complex of late Romanellian period (*underlined by recent use of the name Lepenski Vir-Schela Cladovei by Boroneanţ 1989*), and had extensive communication with the later cultures of the Starčevo-Criş-Körös complex in the late phases of its existence. Its territory, understood as restricted to the Iron Gates Gorge by Jovanović (*1969*), Nandris (*1972*) and Tringham (*1971*) was subsequently enlarged to incorporate not only sites below the Gorge in the Ključ Region, (*Boroneanţ 1980; Mogosanu 1978; Sladić 1986; Srejović 1989; Srejović and Babović 1981; Vasić 1986a*), but also seasonal field camps in uplands such as Baile Herculane (*Nicolaescu-Plopsor et al. 1957*).

The most comprehensive work to-date on the Mesolithic of Iron Gates, by Ivana Radovanović (*1992; 1996a*), provides the chronological framework that I have used in my research. Radovanović has established her chronological division of the Lepenski Vir culture on the basis of the stratigraphy of superimposed architectural elements of which the most important data are provided by analogies between types of hearth constructions, but also in comparison with other architectural elements, mortuary practices, the flint knapping industry and bone, antler and tooth artefacts. By far the best element for the reconstruction of the relative chronology and the chronological relationships of different localities is provided by the stratigraphic position and the typology of hearth constructions (*Radovanović 1992; 1996a; 1996b*). Without entering into details and rationale of her classification, the phases she discerned, together with absolute chronology (given in calibrated years BC), and data relevant for the four sites are presented here. A comprehensive list of absolute dates for the series is provided by Radovanović (*1992; 1996a.App. 3*) together with calibrated dates (*Tasić 1989; 1997*). Only those dates that refer directly to the skeletal material will be considered in detail, together with AMS dates provided by Bonsall *et al.* (*1997*) for Lepenski Vir.

Two reasons can be given to justify this approach. Absolute chronology on the sites is only relatively important, since our determination of any of the strata in the four settlements is based on the economic patterns. If burials can be reasonably accurately associated with any of these occupations then absolute dates do not provide useful additional information. Only in cases where the dates contradict the general temporal framework in which Mesolithic before contact ends at c. 6500 BC and both transitional (contact Mesolithic) and Neolithic begin after that date in the region, will the absolute dates be taken as more informative than stratigraphic information. Given the framework of our study, in which Mesolithic economy can be contemporaneous with Neolithic, it does not assume unidirectional evolution of economic pattern. It simply states that regardless of the economic pattern of a particular site, or phase within the site, once the contact with Neolithic peoples in the region becomes possible, it is no longer regarded as purely Mesolithic but falls within the Mesolithic/Neolithic group, signifying the availability of the contact. The economic behaviour at any particular site will further determine whether it is Mesolithic/Neolithic (with little or no change in the economic domain) or Neolithic (implying increased importance of domesticates).

The second reason concerns the methodology of ^{14}C. Since there is no evidence that dates obtained from charcoal are comparable with dates obtained from human bone collagen (*Bonsall et al. 1997 and quoted literature*) - as the "old carbon" can be ingested from, especially aquatic, foodstuff - there could be important discrepancies that do not reflect actual chronology (*Bonsall 1998 pers. comm.*). Until we have more direct dates from human bones, their value remains tentative.

Dates provided here are from Radovanović (*1996a. App. 3*). The calibration was done by Tasić (*1989*) for Serbian sites and unpublished calibration for Romanian sites based on Radiocarbon Calibration Program 1987 rev.2.0 (University of Washington, Quaternary Isotope Lab) and dates are reported $\pm 1\sigma$.

Here we sumarise Radovanović's chronology as follows:

Phase 1 - According to ^{14}C dates, the *terminus ante quem* for the beginning of this phase is around 7049-6672 BC (Vlasac Ia). This is in accordance with the dates from other sites: 7055 BC Icoana I; 7062 Ostrovul Corbului I - horizon II. Dates from Padina A are even older (7248±103 BC, 7381±58 BC). Therefore, this phase is linked to the second half of the VIIIth millennium BC. This phase is characterised by simple oval hearths bordered by small rocks (Alibeg I, Veterani terrace and Icoana Ia-b). Similar hearths with pressed earthen floors are found at Schela Cladovei and Ostrovul Corbului. Accompanying them on the above mentioned sites as well as at Vlasac Ia and Razvrata I are the oval semi-subterranean houses. The stone construction with graves from Sector III at Padina, and a secondary burial of a skull in Icoana I can be linked to this phase.

Phase 2 - ^{14}C dates are in accordance with Radovanović's determination of this phase on each of the sites (Vlasac Ib 7049-6605 BC; the beginning of Ostrovul Banului III is dated at 7046 BC). In this phase, the formation of the standards of the material culture that will remain unchanged until the very end of the Lepenski Vir culture occurs. Simple hearths are replaced first by ellipsoidal and later by orthogonal hearths. In the early phase of Vlasac Ia they do not present any other constructive elements, while in Vlasac Ib, Hajdučka Vodenica Ia (the earliest sub phase) Proto-Lepenski Vir, Padina A/A-B (sectors I and II) and Ostrovul Corbului I (horizons III and IV) hearths have a receptacle bordered with a row of small rocks or stone slabs. Dwellings are still semi subterranean and oval in shape but some already show the change towards the trapezoid form (Vlasac Ib). Elements of previous phases of inhumation on Vlasac and Schela Cladovei (rearangement of the deceased, diversity in orientation and positions, cremations and the use of ochre) persist.

Phase 3 - Radiocarbon dates from Vlasac II (6970-6470 BC) the beginnings of Razvrata II (6690-6386 BC) and Ostrovul Corbului II (middle layer: 6782-6360 BC) put this phase in the first part of the VIIth millennium BC. This phase is characterised by the same standard hearths from the earlier phase but for the first time we witness differences between Upper and Lower Gorge settlements. For example, in Lepenski Vir I a space for the deposition of ash and the construction of a jamb at the front of a hearth, as well as the traces of construction on the upper hearth slabs, appear. At sites in Lower Gorge (Hajdučka Vodenica Ia and Ostrovul Banului III), these hearths-ovens are different, covered by stone slabs. Dwellings are semi-subterranean trapezoids (the end of Vlasac Ib, Lepenski Vir I phase 1) or above ground, with circular stone constructions (Vlasac II, Hajdučka Vodenica I, Kula I). In the Lepenski Vir I phase, aniconic and ornamented sculptures appear for the first time. In terms of burial practices, this is a younger phase (based on the published graves from Vlasac), characterised by the following changes: the deceased are buried in different positions and with different orientation, the burials are restricted to the space between the houses (Vlasac, Lepenski Vir, Padina A-B and Hajdučka Vodenica) with only young children buried underneath the houses (Vlasac, Lepenski Vir).

Phase 4 - Radiocarbon dates from Phase 2 of Lepenski Vir I (6430-5980 BC) Vlasac III (6425-6130 BC) and Ostrovul Banului IIIb (6610-6170) put this phase in the second half of the VIIth millennium BC. This phase is characterised by the emergence of the 'A' supports in phase 2 of the Lepenski Vir I. Dwellings are still semi-subterranean trapezoids (LV 1, phase 2; Padina B, horizon I) or surface dwellings with circular or orthogonal stone constructions (Vlasac III, Hajdučka Vodenica Ia-b) and the same type of aniconical ornamented sculptures and "altars" are present. In terms of burial practices they remain very much like those of the previous phase except that the orientation of the skeletons tends to parallel the course of Danube (Padina B, horizon I; Lepenski Vir I phase 2; Vlasac III, and Hajdučka Vodenica Ia-b).

Phase 5 - ^{14}C dates for Alibeg II: 6230-5790 BC. The 'A' supports spread to the regions of the Lower Gorge and downstream from the Ključ region (Kula I). The receptacles of the hearths are more often built with stone slabs (Lepenski Vir I-3, Padina B, sector III, Kula I-II). Dwellings are still semi-subterranean trapezoids. Aniconical sculptures and "altars" are still present, although ornamented sculptures are scarcer and ornamentation simpler, while representational sculpture begins to appear. The oldest stone ornamental sculpture on the Hajdučka Vodenica site is stylistically different from those of the Upper Gorge. Mortuary rites are characterised by the same type of burials as in phase 3 and 4.

Phase 6 - The radiocarbon dates suggest the beginning of the VIth millennium BC for the beginning of this last phase of the Iron Gates Mesolithic. This phase is characterised by orthogonal hearths with receptacles constructed by stone slabs and massive 'A' supports (Padina B, horizon III; Lepenski Vir II) in the Upper Gorge and the emergence of a side channel constructed of stone slabs in the Lower Gorge (Hajdučka Vodenica Ib). Concurrently, on the left bank of the Danube, hearths with circular paved receptacles appear on a number of sites (Razvrata II; Ostrovul Corbului II horizon VII; and the sites at km 875 and km 873 on Ostrovul Mare) while on the right bank they are found only in the older horizon of Velesnica. Dwellings are either semi-subterranean or surface dwellings with trapezoid outline (Padina B, Lepenski Vir II). The "altars" and very expressive stone figures are associated only with the oldest layers of Lepenski Vir II. In terms of burial practices, crypts with multiple burials oriented parallel to the flow of the Danube are introduced while earlier forms of burials persist (Lepenski Vir II, Hajdučka Vodenica Ib). The stone and bone industries are typical of the previous phases, as well as excessive use of antler tools. The exception is Padina B (sector III) whose bone industry types and modes of production in phases 4, 5, and 6 are typical for the Old and Middle Neolithic of the region (spatulae, hooks, polished borers). In Padina B horizon II both fine monochrome ceramics and coarse ceramics with silt (sand) and ground straw in the texture are present. The following synchronisation for the four sites in question (Tab. 3) summarises the above chronology and outlines the period when the contact with ceramic producing farming communities in the region becomes established. Although the appearance of ceramics and Pre-Balkan plateau flint does not necessarily imply the "invasion" or even "moving in" of farming communities in the region, it is an evidence of availability of contact between Iron Gates foragers and Balkan farmers. With respect to the proposed research goal, examining interactions between foragers of Lepenski Vir type and Starčevo type farmers as reflected in changes (or lack of them) in the biological (osteological) profile of the Mesolithic inhabitants of the Iron Gates Gorge, the following three phases derived from the above chronology are proposed:

- The *Mesolithic* of the Iron Gates Gorge: appearance on the right bank of the Danube of large formal disposal areas, sedentary or semi sedentary population practising hunting of large game (red deer and auroch for the Upper Gorge and red deer and wild pig for the Lower Gorge), gathering of wild plants, and fishing. No contact with farmers is possible as there are no accessible farming communities. This period lasts from the early VIII^th^ millennium to the end of the first half of the VII^th^ millennium.
- The *Mesolithic/Neolithic*, (also referred to in the text as *Transitional* or *Contact*) period in the Iron Gates Gorge is characterised by the same Mesolithic economy, same material culture and ideology, and possibility as well the evidence of contacts with farmers. Essentially, this is a population that remained fully Mesolithic while there was an agricultural frontier with incipient possibility of contact, an equivalent to Zvelebil's "availability phase" (*Zvelebil 1996a*). The period begins with the first farming communities in the region (Anzabegovo, Gura Baciului) in the second half of the VII^th^ and lasts until the end of the first half of the VI^th^ millennium, when the fully Neolithic economy is introduced in the region, or at least on the sites where it is present. Material evidence for the contact consists of Pre-Balkan plateau flint and ceramics of Starčevo type.
- The *Neolithic* period in the region is characterised by the introduction of a farming economy and reliance, not necessarily exclusive, on domesticated animals and plants. In terms of material culture it is also characterised by Starčevo complex elements: pottery of Starčevo-Cris type, polished stone axes, Neolithic blades on imported flint, pit houses and burial practices typical for this period. It is evidenced on the Lepenski Vir site phase IIIb, Vlasac IV, and Ajmana and Velesnica downstream from Ključ. In the region, different sites would have different dates for this phase, depending on the appearance of a fully Neolithic economy in the region, starting theoretically in the second half of the VII^th^ millennium and ending with the change from Middle Neolithic Starčevo to Late Neolithic Vinča-Dudeşti in the region.

3.4. People

The function of the Iron Gates sites is still a subject of debate. Recently, a solar cult was proposed as an explanation of the structure and position of houses at the site of Lepenski Vir I and II (*Babović 1998*). The function of Vlasac as a habitation or cemetery site was discussed by Chapman (*1993*) in terms of his landscape markers/social landscape argument. Jovanović (*pers. comm.*) perceives Hajdučka Vodenica as a burial-ritual rather than a habitation site. At this stage we can point out that strict distinction between ritual, ancestral, mortuary, economic and

phase-millennium BC		Padina	Lepenski Vir	Vlasac	Hajdučka Vodenica
6	– mid. 6^th^	B(III)	II/IIIa	–	Ib
5	– 7^th^/6^th^	B(II)	I(3)	–	Ia
4	– 7^th^–2^nd^ half	B(I)	I (2)	III	Ia
3	– 7^th^–1^st^ half	A–B	I (1)	Ib–II	
2	– 8^th^/7^th^	A/A–B	Proto LV	Ia–b	1a
1	– 8^th^	A	–	Ia	–

Tab. 3. Synchronisation for the sites in question: shaded areas represent appearance of the ceramics in the stratum: light shade - sporadic appearance, darker shade - ceramic is common as well as Pre-Balkan plateau flint, "Montbany type" of chipped stone blades along with the geometric microliths. (*Based on Radovanović 1996a.289; 1996b; 1996c; Radovanović and Voytek 1997*).

habitational, need not have existed at the time of the formation of the sites. The position and meaning of these sites in respect to those on the left bank of the Danube could have been special, although it is hard to see how this special status would contradict the permanence or sedentism as Whittle argued (*Whittle 1996*). While all these claims might be reasonable and not necessarily contradictory to each other and earlier interpretations, any discussion of the function of these sites without revised analyses of all of the elements of habitation - burial - portable artefacts is tenuous at best. Further research and analyses of abundant but yet unpublished documentation is necessary.

Skeletal remains are found on all of the sites on the right bank of Danube save for Stubica. This site was discovered when the water level was already very high and only a small-scale excavations were possible (*Jovanović 1984b*). On the Romanian side, only Schela Cladovei had important numbers of burials unearthed (33 +), other sites have either isolated bone fragments (Cuina Turcului and Icoana) or 1-3 burials (Icoana III, Ostrovul Corbului I, III). The recent excavations at Schela Cladovei (*Boroneanț et al. 1995*) have produced several more unpublished graves.

Revision of the osteological material from all four sites has shown that minimal number of individuals (MNI) reported for any of the sites is incorrect, as it disregards many fragmentary skeletons as well as individuals represented by single bone fragments. The detailed analyses of skeletal parts representation have not yet been published (*Roksandić in prep.*) and theories based on published anthropological reports that deal with these phenomena might need to be revised. A joint project with the Institute of Archaeology (Serbian Academy of Arts and Sciences) and Faculty of Philosophy (Belgrade University), that would deal with the detailed analyses of the function of these sites, is envisaged. Documentation gathered during excavations on all four sites appears to be sufficient to warrant a more thorough and detailed analysis of habitation and burial patterns.

3.5. Sites

The four sites on the right bank of Danube (Fig. 3) that have yielded osteological material are Padina, Lepenski Vir, and Vlasac in Upper Gorge, and Hajdučka Vodenica in the Lower Gorge. Of the sites downstream of the Ključ region Kula has also yielded five Mesolithic burials, while Velesnica has yielded six (*Vasić 1986*) and Ajmana 16 Neolithic skeletons (*Radosavljević-Krunić 1986; Stalio 1986*). Of these, only the six skeletons from Velesnica were available for examination during my research season in Belgrade.

3.5.1. Padina

Salvage excavations of Padina were carried out from 1968 to 1970 (inclusive) by a team from the Archaeological Institute of Belgrade directed by Borislav Jovanović (*Jovanović 1968; 1969; 1970*). A large-scale excavation was divided into four sectors corresponding to three natural escarpments that were themselves divided by very steep blocks (Figs. 4, 5 and 6). The site is located in the Upper Gorge, on a very steep slope (in Serbian *padina* means 'a slope') that greatly influenced the architecture and mode of construction of the trapezoid houses, typical for the Lepenski Vir culture.

Unfortunately, alterations in the course of Danube had destroyed certain portions of the site, filling the gullies and ravines with massive deposits of silt and stone. B. Jovanović believes that a large portion of Mesolithic Padina would have been severely eroded by this natural process.

The following stratigraphic units were discerned by the principal investigator: A - Mesolithic, B - Early Neolithic, C - Aeneolithic, D - Iron Age, E - Roman period and F - Middle Ages (*Jovanović 1987*). Phase B is further divided in 3 subphases that correspond with Starčevo periodisation. Radovanović claims that both Padina A and B are Mesolithic in character as their subsistence is based on sedentary hunting-gathering-fishing economy. She proposed the following reconstruction of the stratigraphy relative to the chronology and synchronisation with other sites, based on field journals and site maps (*Radovanović 1996a*):

Padina A - Early Mesolithic phase I of the Iron Gates chronology - synchronous with Alibeg, Vlasac Ia, Schela Cladovei I. Srejović's interpretation is different in that he synchronised Padina with Proto-Lepenski Vir, Vlasac I, Schela Cladovei I, Ostrovul Banului IIIa, and Icoana I (*Srejović 1989*). Voytek and Tringham (*1989*) propose a Late Mesolithic date synchronous with Vlasac II-III, Lepenski Vir I-II, Ostrovul Corbului III, Schela Cladovei II Ostrovul Banului IIIb and Icoana II.

Padina A-A/B - Mesolithic phase II of the Iron Gates - synchronous with Vlasac Ia-b, Hajdučka Vodenica Ia, Schela Cladovei I and Proto Lepenski Vir.

Padina A/B – Mesolithic phase III of the Iron Gates - synchronous with Lepenski Vir I(1), Vlasac Ib–II, Hajdučka Vodenica Ia, Kula I, Schela Cladovei II.

Padina B(I) – Mesolithic phase IV of the Iron Gates - synchronous with Lepenski Vir I(2) Vlasac III.

Padina B(II) – Mesolithic phase V of the Iron Gates - synchronous with Hajdučka Vodenica Ia, Lepenski Vir I(3), Kula I–II, Icoana II.

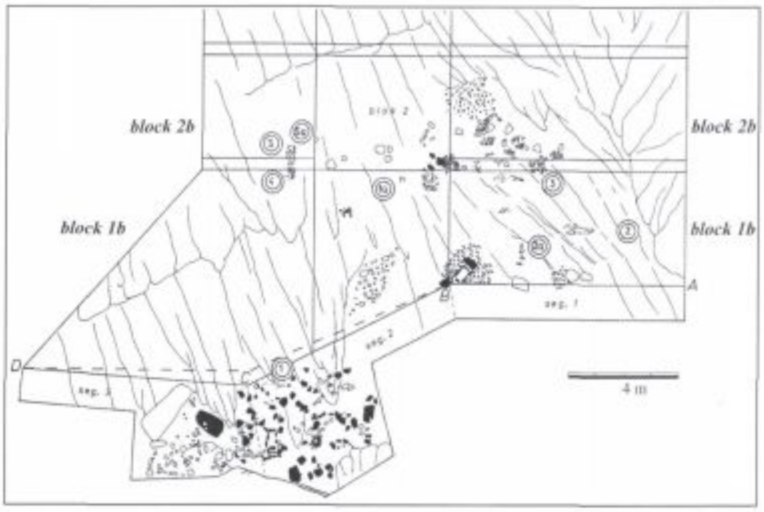


Fig. 4. Padina Sector I. Unpublished site plan. Courtesy of B. Jovanović. Burial numbers are given in circles.

Padina B(III) – Mesolithic phase VI of the Iron Gates - synchronous with Lepenski Vir II, Hajdučka Vodenica Ib. According to Srejović, Padina B1 belongs to the Late Mesolithic - Lepenski Vir I–II, Vlasac II–III, Icoana II, Hajdučka Vodenica, Schela Cladovei II, Ostrovul Banului IIIb; Padina B2: Transition Mesolithic/Neolithic - Kula, Alibeg, Ostrovul Mare; and Padina B3: Early Neolithic - Lepenski Vir IIIa, Cuina Turcului III. Voytek and Tringham consider B1–3 as transitional Mesolithic/Neolithic, Jovanović as classical Starčevo (Starčevo II) and Gimbutas as Starčevo IIa–b, Gura Baciului II.

In Radovanović's system, the appearance of pottery occurs early as phase IV of the Iron Gates Mesolithic. Domesticated sheep/goat and cattle represent a very small percentage of the total faunal material. Although the difference is non-significant, it seems anomalous that they are more abundant in Mesolithic Padina A (1.19%) than in Neolithic Padina B (0.65%). However, since the details of stratigraphy were not available to A. Clason at the time of her analysis, the most plausible explanation is that all of the domesticates belong to the Padina B horizon. Although this would increase the number of domestic animals present at the site in the contact period, their importance would still be economically negligible (less than 5%), but would indicate, together with ceramic and imported Balkan flint, a porous agricultural frontier in the Gorge from the first half of the VII^th^ millennium BC.

Absolute dates for Padina range from 9331±58 BP (BM-1146) to 6570±80 BP (Grn-8229) (Tab. 4). The "BM" dates are derived from skeletal material while the "Grn" dates are from different charcoal samples and should be compared with care. Calibrated, these dates range from 7381±58 BC to 5568–5411 BC (the latter encompasses 78% confidence interval or 1σ according to Tasić (*1997; 1989*)).

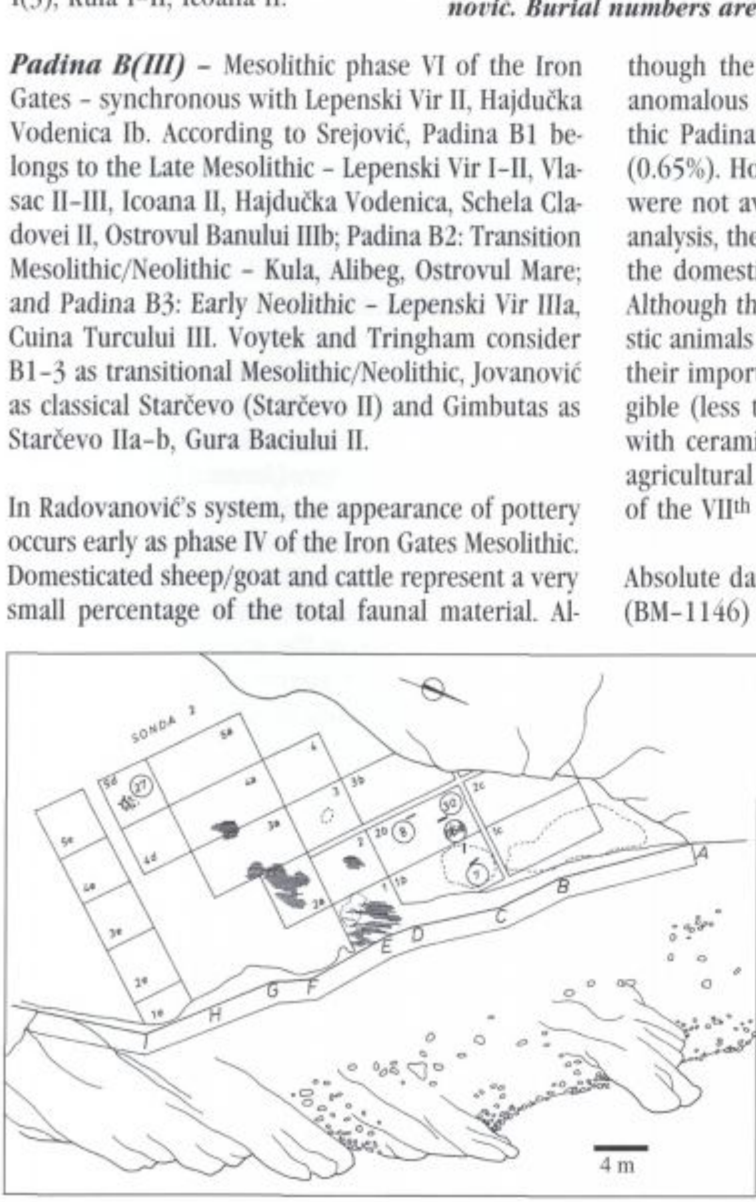


Fig. 5. Padina Sector II. Unpublished site plan. Courtesy of B. Jovanović. Burial numbers are given in circles.

All human skeletal remains belong to phases A and B and are therefore relevant to this study. Human skeletal remains comprise 48 individuals found within grave units and 73 fragmented "scattered human remains" that were found during analyses of the faunal assemblage by A. Clason and V. Dimitrijević (*Jovanović pers.*

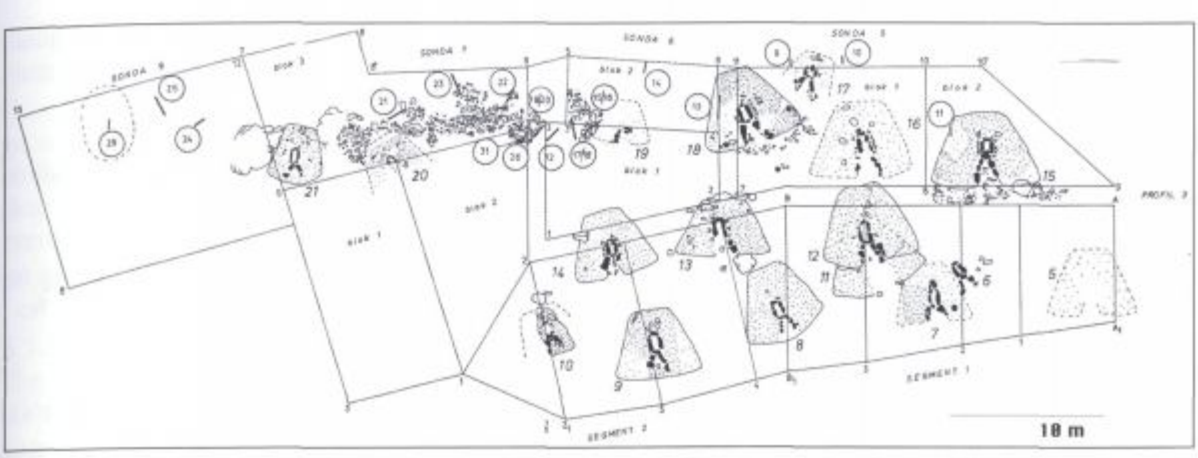


Fig. 6. Padina Sector III. Formal disposal area and habitation structures. Unpublished site plan courtesy of B. Jovanović. Burial numbers are given in circles.

comm.). Three adult individuals from the Sector III and one juvenile from sector II have a sufficient number of matching bones to represent destroyed unidentified graves. It is impossible, with the current state of the analyses of the documentation associated with the scattered human remains, to advance any explanation for their occurrence. We know that they are not uncommon in other sites in the region as well as in the early Neolithic strata of Anzabegovo and Middle Neolithic Starčevo site of Zlatara (*Leković 1985*). Meiklejohn has pointed out that this seems to be a very general problem in European Mesolithic: namely, if the preservation of bones at the site is good, some human remains, not necessarily associated with burials, are likely to be found (*Meiklejohn and Denston 1987*). That they could represent secondary burials of small or few fragments of human remains is shown by the occurrence of very small fragments of "extra" individuals within closed and undisturbed primary burials on all of the Iron Gates Gorge Mesolithic sites. However, the disturbance of earlier burials within a settlement cannot be excluded. It is hard to estimate the MNI for these remains, as taphonomic histories for all of them cannot be discerned with any precision. Although it was possible to plot all of the fragments on the general site plan, according to the unit and layer of excavations, these units were too large to provide relevant information. Detailed pairing (*sensu Duday 1985*) was impractical within the time constraints of the field season. More detailed taphonomic analysis that should take this phenomenon into consideration is planned in future. At this point, since these skeletal elements are too fragmented to provide information on either demographic, metric or non-metric traits of the individuals, they are excluded from further discussion.

Minimal number of individuals (MNI) for the site as a whole amounts to 52 individuals (as, at least theoretically the 73 scattered fragments could have belonged to these 52 individuals). The skeletal representation ranges from small fragments to whole skeletons. Of them, 26 individuals were buried in single, and 14 in double graves, while three grave units had three, four and five individuals each.

Only eleven individuals were assigned sex based on their pelvic morphology, mainly the pubic features, sciatic notch shape and presence and shape of preauricular sulci. Five individuals were determined as male and six as female. Since size and robusticity are one of the parameters often invoked in discussion of differences between Iron Gates population(s) and are part of the analysis in this thesis, sex assignment based on features of the skull and postcranial skeletal robusticity was deemed inappropriate. However, the sex thus assigned was noted and distinguished in tables by a question mark: m? is represented by further 6 individuals and f? by 12 individuals. If robusticity proves to distinguish between sexes rather than populations, this supplementary information can always be incorporated into later analysis. It was not pos-

Period	Grave no.	Lab ID	^{14}C age BP
Mesolithic/Neolithic	Grave 7	BM–1144	8797±83 BP
	Grave 2	BM–1143	7738±51 BP
Mesolithic	Grave 14	BM–1147	9198±103 BP
	Grave 12	BM–1146	9331±58 BP
	Grave 39	BM–?	9292±148 BP

Tab. 4. Absolute dates for Padina (*from Burleigh and Živanović 1980*).

sible to assign sex with any accuracy in the case of 13 individuals.

Adults represent the majority of the individuals buried at the site: 44 of the 52 individuals or 85%. In one case it was not possible to determine if the individual was an adult. Among subadults three neonatal skeletons were identified, one child between 2-5 years of age, two between 6-11, and one 12-18 years of age. Among adult individuals ten are less then 40 years old, while nineteen are older than 40 years. For the remaining 15 individuals, it was possible only to state that they are adults. Since demographic data play such an important role in many discussions, the approach was deliberately conservative and sex and age were assigned only in those cases where there was sufficient preservation of relevant features. Ages were assigned in wide categories of young adult, old adult, adult.

I was able to use S. Živanović's anthropological notes as part of the original archaeological documentation kindly provided by Dr. B. Jovanović during the 1996 and 1998 field seasons. The complicated denomination of both burials and individuals is due to the confusion caused by Živanović's insistence that graves should be numbered by a physical anthropologist after the excavation, when he could provide details on numbers of individuals. Since Živanović was not present during the excavations, and in his labelling did not respect the natural associations of the skeletons nor the actual MNI in the burials, it was very difficult to associate (through photos, drawings and provenience points) numbers on skeletons with associated field drawings. When I started working on the osteological material from Padina in the summer of 1996, most of it was not cleaned, although S. Živanović published measurements and other anthropological data. To avoid further confusion, labelling was based on the numbers he had given to the skeletons with reference to the actual number of individuals. For example number 14 was kept for the principal individual, and the fragmented skeleton that was found during the analysis of that grave was labelled as 14(1) and treated as an "extra" individual within the grave. The complex nomenclature of 15-16 is the direct result of this approach. Although Živanović recognised only skeleton 15, 16 and later 16a, we have discerned at least five individuals within the grave. Some of the unrecognised individuals had well-preserved fragments of long bones that are easy to recognise and lateralise, and my impression was that Živanović based his MNI counts on the skull and mandible fragments without any reference to the postcranial skeleton. The same situation was observed in multiple graves at Hajdučka Vodenica.

According to the presented chronology of Padina and the division of the site strata into Mesolithic and Mesolithic/Neolithic contact, skeletal remains were assigned to either of the two periods according to the site documentation, superposition of certain features and Radovanović's analysis of the burials.

The following 18 individuals belong to the Mesolithic period in Padina:

single burials: 1; 18b; 21; 22; 39; *double* burials: 12; 12(1); 14; 14(1); 17; 17(1); 23; 23(1); *multiple* burials: 15(15-16a); 15-16(15-16a); 16 (15-16a); 16a(15-16a); 16(1)(15- 16a).

To the Mesolithic/Neolithic Transition belong the remaining 31 individuals:

single graves: 1a; 3; 6; 7; 8; 9; 10; 11; 13; 18; 19; 24; 26; 26a; 27; 28; 29; 30; *double* graves: 2, 2(1); 6a, 6a(1); 25, 25(1); *multiple* grave: 4/4+5+5a/, 5/4+5+5a/, 5a/4+5+5a/, 5a(1)/4+5+5a/; 20, 20(1), 20(2).

It was not possible to assign four individuals from the disturbed unidentified graves into either of the periods with any accuracy.

Absolute dates derived directly from human bones (*Burleigh and Živanović 1980; Radovanović 1996a, App. 3*) coincide well with the relative chronological attribution of the graves by Radovanović (*1996a*).

The only publications of the osteological material from Padina to date are the preliminary reports by S. Živanović (*1975a; 1975b; 1975c; 1976b; 1976c; 1979b; 1988*) who concentrated mainly on their typological affinities. In 1973 he concluded that humans from Padina represent a homogenous, autochthonous and isolated group of people that lived at the locality for 1500 years or more. According to him, although the population is typical Cromagnoid in character, it has some traits of later Neolithic populations and is therefore obviously in transition. In one of his later articles he determined the Padina population to be "Proto-dinaric" (*Živanović 1975a, 165*) while still later based on two ^{14}C dates obtained from human bones (6487±83 BC and 7248±103 BC) he claims that the individuals buried at this site are the first representatives of Cro-Magnon population in the region (*Živanović 1976b*). While it was possible to reconstruct serial numbers of the individuals on which he bases his "Proto-dinaric" type (18a, 25 and 26), no data are given for his "Cro-Magnon" specimen. Further on, he claims that the bones of the postcranial skeleton show numerous marks of gracilisation. He also notes an average height of 170 cm. (Reconstructed on the basis of one set of postcranial bones. *Sic!*).

3.5.2. Lepenski Vir

The expressiveness of the Mesolithic sculpture from the site of Lepenski Vir prompted Srejović to propose that: in the harsh and unpredictable environment of the Gorge, where light and dark suppress each other quickly, where no form or distance is constant and where no silence can ever be heard, people could survive only if they sharply and decisively delimited the boundaries of their world. This would both separate them from nature and provide the necessary balance with it (*Srejović 1969.27; later exploited by Hodder 1990*). In the rich environment of the Gorge, the quest for survival would not have been in the economic domain but in the spiritual realm, as more energy was needed to subdue and bring to human measure the chaotic movements and amorphous shapes that are constantly present in the outer world. Srejović's (*1969*) appreciation of the natural phenomena at Lepenski Vir differs remarkably from the present-day situation. Today, the site is located on a relatively high terrace, the Danube river has become easily navigable by large barges and the whole scenery is pervaded with peace. The description of the dramatic changes in the light, shape and distances during the day is no longer there, yet the impressive artistic achievement and sophisticated social and ritual play at the site still demand explanation.

The name Lepenski Vir is derived from the existence of the whirlpool in front of the site that has, apparently, played an important role in fishing (in Serbian *vir* means 'whirlpool'). The site is located in the middle of the Upper Gorge on a semicircular terrace on the right bank of the Danube, bordered by a very steep slope of Korsho hill (Fig. 6). It was first noted as an archaeological site during a survey in 1960 and was believed at the time to be a small village of the Starčevo culture. In 1965, when Srejović begun excavation, a great (central) portion of the Neolithic (Starčevo) village had already been destroyed by the activity of the Danube. However, under the layers of the Starčevo village (observable in the profiles formed by the erosive activity of the Danube), the site of an earlier period emerged. In subsequent years, an area of $2500m^2$ was excavated to reveal architecture, monumental sculpture and graves of the Lepenski Vir culture. The archaeological layer was 3.5 m deep on average. Some $1700m^2$ of the eastern part of the terrace were destroyed by the activity of the Danube and another $3000m^2$ of the site proper remained unexcavated. In 1969, one of the floor plans of the excavated portion of the site was cut into blocks and reconstructed on the terrace some 30 meters above its original setting. Considering the extent and depth of the excavated area and the incredible speed with which it was done (approximately 12 months altogether) the methodological approach of the team of the University of Belgrade, led by Srejović was remarkable, in that much economic and ecology oriented data were gathered and a number of charcoal samples was obtained for ^{14}C dating. The extensive documentation offers the possibility that the site can be reconstructed in more detail. However, apart from Srejović's publications in 1969 in Serbian and 1972 in English, and some articles and catalogues on the monumental art of Lepenski Vir, little has been published in detail, and while sculptures and house floors have figured in at least one monograph (*Srejović and Babović 1983*) graves never received a comprehensive treatment.

Srejović discerned four major horizons separated by more or less substantial changes in soil colour, that define four major stages in the development of the site: Proto-Lepenski Vir, Lepenski Vir I a–e (Fig. 7), and Lepenski Vir II (Fig. 8) belonging to Mesolithic period and a Lepenski Vir III layer that belonged to the Neolithic culture [6]. In his early publications Srejović (*1968; 1969; 1971*) argues for a local development of the Neolithic in the region and divided development phases into Proto-Starčevo and a Starčevo that were both present at the Lepenski Vir site. Although his observations of continuity were appropriate, the argument could not withstand the critique by Jovanović and Garašanin, who argued that Starčevo comes to Lepenski Vir in its fully developed "classical" phase (*Garašanin 1980*). The synchronicity of some of the Lepenski Vir houses at Padina with fully developed Starčevo II ceramic ware was used by Jovanović (*1987*) to argue for a Neolithic date and context for the Lepenski Vir material. Srejović has moderated his view in his later publications (*Srejović 1979; 1989*) and his local continuity came to incorporate contact with surrounding far-

6 Unfortunately, no general plan was available for this period.

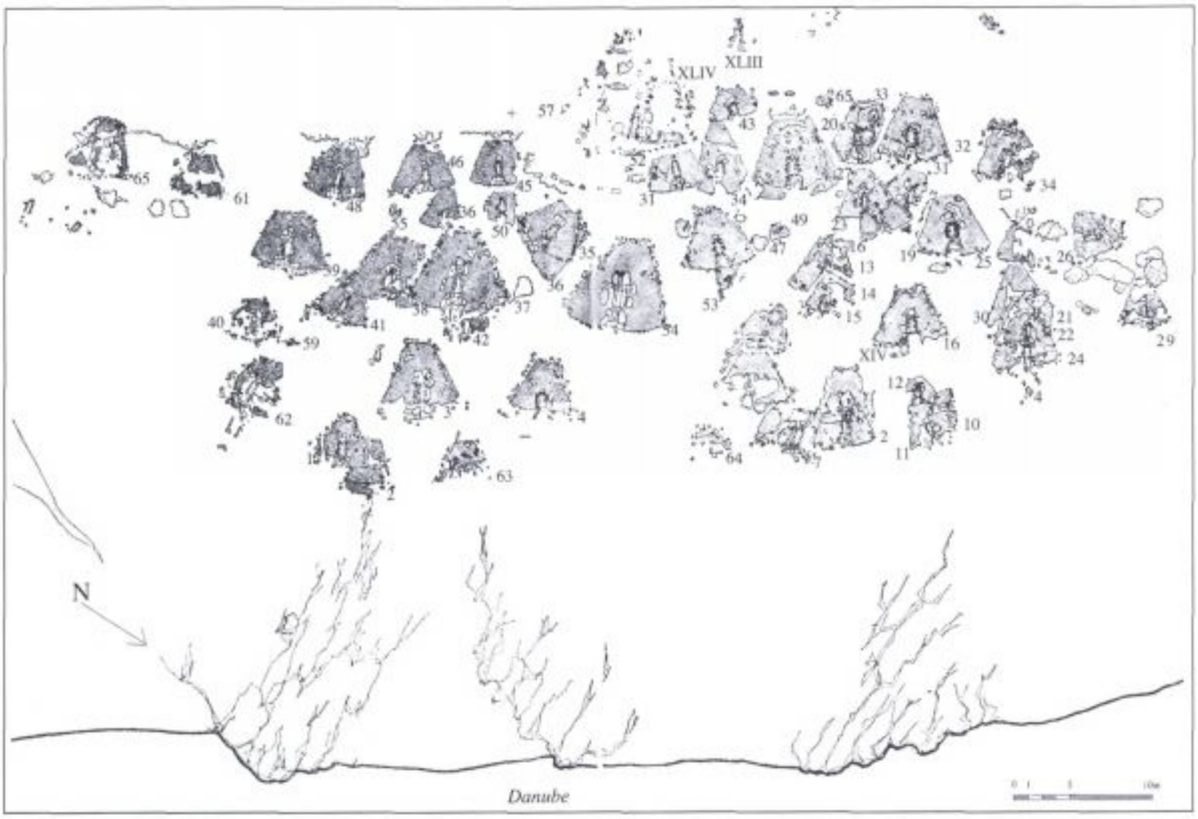


Fig. 7. Composite plan of the Lepenski Vir I (a-e) settlement. (*Adapted from Srejović 1969.52–53, Fig. 7*).

ming communities as part of the explanation for the development of the Lepenski Vir sequence [7].

While Radovanović (*1996a*) keeps the basic distinction between horizons, she has argued for different interpretation of spatial organisation of the site and has concluded that Srejović's five building phases in Lepenski Vir I represent eleven cycles of the re-building of the settlement. Her argument is based on stylistic analysis of hearths within superimposed houses and, since it was tested and confirmed on superimposed houses in Padina, it is more convincing. These 11 re-building incidents are grouped in three chronological units that are important to this study. As her phases do not always incorporate all of the buildings that Srejović assigned to his phases of the horizon LV I it would be hard to present a comparative table. No detailed plans of the site that would include the distribution of the burials are available as yet although Babović is currently working on their reconstruction (*Babović pers. comm.*). Schematic representation of housefloor plans in different phases of settlement can be found in Srejović (*1969; 1979*) and Srejović and Babović (*1983*). More detailed discussion can be found in Radovanović (*1992; 1995; 1996a*).

Proto-Lepenski Vir: small settlement along the bank of the cove that extends over 90 m.

Lepenski Vir I -1: A settlement with two central zones - one for the upstream part of the settlement, and the other for the downstream part.

Lepenski Vir I-2: In this phase there is only one central house (54) around which other dwellings are rebuilt. The extreme upstream and downstream buildings represent another evidence of concern for symmetry. This is the phase of consolidation (*Radovanović 1996a.109*) but also of sporadic appearance of pottery and Pre-Balkan Plateau flint. The settlement is synchronous with the Neolithic of the region and these occurrences provide evidence for an exchange (trade) relationship with farming communities in the vicinity.

Lepenski Vir I-3: During this phase habitations "move" towards the rear of the terrace; there is a lot

7 I met Prof. Srejović for the last time in 1996 in Belgrade, several months before his untimely death from cancer, and we discussed my project. He shared his unchanged fascination with the site and its meaning with me, and it became apparent that he changed his original ideas significantly. However, the idea of ideological continuity in the region was still strongly present.

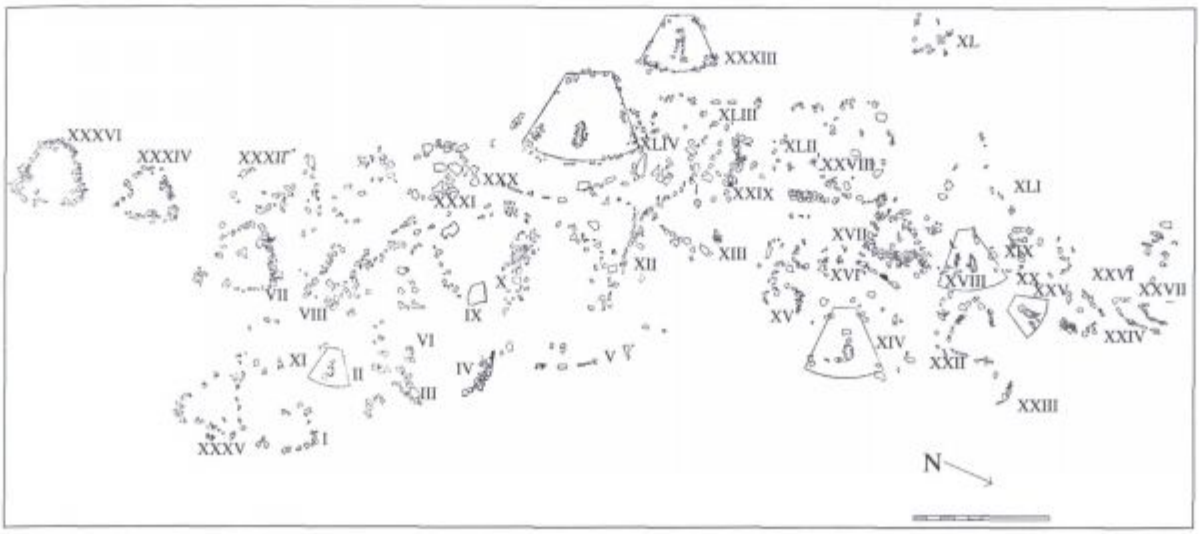


*Fig. 8. Composite plan of the Lepenski Vir II settlement. (*Adapted from Srejović 1969.78-79, Fig. 18*).*

of rebuilding activity, and the house 57 stands out as the largest house in the whole sequence.

Lepenski Vir was abandoned for a period of time (testified by a thin layer of brown loessic sand observed at places between the LV I and LV II settlements (*Srejović 1966.13; Radovanović 1996a.113*). There are significant differences in the organisation of the settlement, with supporting walls and artificial terraces. However, the houses are often at the same spot as the houses of the previous phase (*Srejović 1969.78–81*).

Lepenski Vir III is not considered by Radovanović as she deals only with Mesolithic strata. It is divided into LV IIIa perceived by Srejović as early Neolithic and LV IIIb – Middle Neolithic Starčevo settlement. If the evidence for contacts with Neolithic communities from LV I is taken into account, the designation of the LV IIIa into early Neolithic is somewhat problematic. It is supposedly synchronous with Gura-Baciului and arguably different from the classical Starčevo complex – at least based on its ceramic production. Since the ceramics from Lepenski Vir have not yet been thoroughly examined in the light of new interpretation of Starčevo development (*Tasić 1998*) further discussion is fruitless. However, the high percentage of game and fish, as discussed earlier, argues for substantial influence of local tradition.

Absolute dates for Lepenski Vir were obtained from charcoal samples and have caused considerable discussion, especially on the dates of the Neolithic settlement. Since these are not crucial to our analysis, only the dates reported by Bonsall *et al.* (*1997*), derived from human bone collagen are examined here. Unfortunately, R. Lennon, who collected the bone samples in 1989, made only Lepenski Vir III material available for processing, although many more specimens were collected [8]. The dates (Tab. 5) have quite a wide range (from 6993 to 5593 BC) although they are all derived from the Neolithic phase of the settlement.

These dates do not coincide with Radovanović's and Srejović's archaeological determination of the site sequence and present a considerable problem. However, since they are only few and all of them are from a single phase in the sequence, the phase that seems to have been the most readily discerned by the field crew and since a possibility of them being contaminated with the ^{14}C from the ground water,

Skeleton number	Lab ID	^{14}C age BP	cal BC age 1σ	cal BC age 2σ
31a	OxA–5827	7770±90	6621–6462	6993–6414
44	OxA–5830	7590±90	6463–6267	6552–6189
32	OxA–5828	7270±90	6178–5990	6229–5897
88	OxA–5831	7130±90	6018–5970	6159–5763
35	OxA–5829	6910±90	5840–5667	5954–5593

*Tab. 5. Absolute dates. Lepenski Vir III settlement (***from Bonsall et al. 1997.Tab. 6***).*

8 As evidenced by bones from all three periods that have been severely damaged by collection of unnecessarily large samples, more dates could have been available.

it is hard to incorporate these dates in the present study. Until more dates are available their value remains tentative.

Human remains examined in this study come from all three settlements. They comprise 190 individuals from 134 graves plus 34 adults, five subadult individuals and three newborns from different unidentified contexts. Of note is that many of the "scattered" adult remains bear traces of ochre. However, until a more detailed study of taphonomy is done and full access to field data is available, the explanation for these bones cannot be offered. Some of them are no less well preserved than some of the remains with associated grave numbers. However, since none of them have sufficient features for either demographic, morphometric or non-metric analysis they are excluded from further discussion.

MNI for the site as a whole amounts to 190 individuals (as at least theoretically these 42 "scattered human remains" could have belonged to them). Skeletal representation ranges from small fragments to complete skeletons. Of them 101 individuals were buried in single, 58 in double graves, three graves contained three individuals, while four, five, six and seven individuals were buried in one instance each.

Only 25 individuals were assigned sex based on pelvic morphology (same procedures as described for Padina). Females are represented by 11 positive determinations and males by 14. The site has a particularly high proportion of neonatal skeletons: 51 individuals or 27%. These burials are most often associated with house construction (underneath the floor) but also they are found within adult burials as well, often represented by only one bone fragment. A further 33 skeletons belong to children of different ages: 2–5 years old by seven individuals, 6–11 years old by 13 individuals, 12 –18 years old by eight individuals, while for five subadults it was impossible to determine age. The total for adults is almost identical as for subadults (83 compared to 84) while no age could be assigned to 23 individuals.

As with the collection from other sites, previously non-identified individuals were given the same number as the noted grave with the additional serial number in brackets.

According to the presented chronology of the site and division of the strata into the Mesolithic, Mesolithic/Neolithic contact and Neolithic periods, skeletal remains were assigned to one of the following phases according to site documentation (kindly provided by Prof. Srejović, the principal investigator) for the Neolithic burials or Radovanović's analysis of Mesolithic burials (*1996a.174–189*):

The following 32 skeletons have been assigned to the Mesolithic period:

single burials: 3; 21; 22; 46; 60; 61; 67; 69; 110; 111; 112; 113; 117; 118; 119; 120; 121; 132; 133; *double* burials: 50, 50(1); 64, 64(1); 99, 99(1); 102, 102(1); 109,109a; *multiple* burials: 101, 101(1), 101(2).

It is interesting to note that 17 of these individuals are newborn babies found underneath the house floors (all of the numbers above 100).

To the Mesolithic/Neolithic contact period belong following 68 individuals:

single burials: 11; 12; 15; 16; 17; 23; 26; 28; 46; 68; 70; 90; 91; 92; 94; 95; 96; 97; 100; 103; 104; 105; 115; 116; 122; 126; 127; 128; 129; 130; 131; 134; *double* burials: 7a, 7b; 13, 13(1); 14, 14(1); 45a, 45b; 63, 63(1); 74, 74(1); 93, 93(1); 98, 98a; 99, 99(1); 106, 106(1); 107, 107(1); 108, 108(1); 114, 114(1); 123, 123(1); 124, 124(1); 125, 125(1); *multiple* burials: 54a, 54b, 54c, 54d, 54d(1), 54e.

Newborns represent 29 of these burials, most of them found underneath the house floors once the site was removed onto a higher terrace, as evidenced by their high sequence number (≥100) assigned during excavation.

To the Neolithic period Lepenski Vir IIIa and IIIb belong the following 40 individuals:

single burials: 1; 4; 5; 6; 8; 9; 20; 31a; 33; 35; 37; 38; 39; 42a; 43; 44; 48; 51; 53; 56; 57; 59; 66; 71; 88; *double* burials: 18, 18(1); 19, 19a; 32a, 32c; 52, 52a; 55a, 55b; 73, 73(1); *multiple* burials: 83a, 83a(1), 83b.

Unfortunately, for 48 burials there was not enough information to provide chronological assignment:

single burials: 2; 10; 24; 25; 29; 36; 40; 41; 49; 58; 62; 65; 72; 75; 76; 78; 86; *double* burials: 77, 77(1); 80; 81; 82; 84, 84(1); *multiple* burials: 27a (27a+e), 27(27b), 27 (27C), 27 (27d), 27(1), 27 (27f), 27(2); 34a, 34b, 34c; 79a, 79b, 79c; 85, 85a, 85b/85(1)/, 85b; 87, 87(1), 87(2), 87(3), 87(4); 89a, 89b, 89b(1).

The skeletal material has received little detailed publication. Presented in Srejović's book (*1969.239–257*) by Nemeskeri in a preliminary report it gives little information on the structure of the population. Nemeskeri, in keeping with the traditional approach of Central European anthropology was most interested in demographic profiles and typological determination of sub-populations. He distinguishes 2 major types further divided into 2 subtypes each, and concludes that for the differences between early and late population of Lepenski Vir (from the phase I to that of IIIa) to have evolved *in loco*, it must have taken 125 generations, or 2500 years. He therefore discarded the possibility of local evolution and argues for abrupt population change (*Nemeskeri 1969. 255*). Mikić has dealt with the entire Iron Gates Gorge series in his works on the process of neolithisation in Iron Gates Gorge (*Mikić 1981a; 1989*) and argues for the *in loco* evolution. Zoffmann (*1983*) has made an important contribution to anthropological publication on Lepenski Vir, and although sex and age determinations for individual skeletons were not reported, I was able to use the original documentation (kindly provided by Prof. Srejović in 1996) in which sex and age determinations were given by Zoffmann. However, in the following season, in keeping with revision of sex determination for osteological material from other sites, I have reassessed sex using a more conservative approach based exclusively on pelvic morphology. It was interesting to note that differences in sex assignment were least important between my assessments and hers, while they differed considerably between both my and Nemeskeri's results, and my and Živanović's results. The major reason for this could be that the two later authors based most of their conclusions on cranial remains.

3.5.3. Vlasac

Vlasac was found at the very end of the campaign in the late summer of 1970. In the autumn of 1970, 432m^2 of this site, situated in the Upper Djerdap Gorge downstream from Padina and Lepenski Vir, were excavated. A further 208 m^2 were excavated in 1971, right before the inundation by the accumulation lake of the Djerdap Hydro-plant. In less than four months, the team of archaeologists, geologists, architects, and students unearthed 43 dwelling structures, 87 graves and more than 35 000 mobile objects. The monograph of the site was published in 1978 and is the most comprehensive publication on archaeological, environmental and anthropological data on any individual site of the Lepenski Vir culture (*Bökönyi 1978; Buczko et al. 1978; Carciumaru 1978; Srejović and Letica 1978*). The graves are treated and presented individually with relevant data on position, orientation, age and sex, and accompanied by drawings and pictures (Figs. 9, 10 and 11). The anthropological report is extensive and besides chapters on methodology, demography, pathology, dating, and sex and sexualisation (sexual dimorphism change over time) gives individual data for each of the skeletons (*Nemeskeri 1978; Nemeskeri and Lengyel 1978a; 1978b; Nemeskeri and Szathmary 1978a; 1978b; 1978c; 1978d; 1978e*). It is of extreme importance to any of the metrical analyses, and also has all the relevant information on the dates obtained from human bones, useful in comparisons of stratigraphic assignments by researchers with Radovanović's (*1992; 1996a*) chronology discussed below. However, a revision of the osteological material has shown numerous discrepancies between Nemeskeri's and my assessment of MNI and sex. During the 1996 campaign this difference started to appear, first and foremost in the number of individuals per grave. My first impression was that poor storage conditions had caused some mixing of the material. In 1998 campaign, this conclusion was dropped for a number of reasons: the mixing of the material had to be considerable to allow for such large discrepancies, the "extra" individuals were represented either by fragments of long bones, or very small fragments of skull. At least in one case (grave no. 7) a decorated bone implement (Fig. 12) was found with the postcranial remains.

In at least one case a whole coxal bone could be reconstructed where Nemeskeri assigned sex on the basis of the skull (grave no. 4a). The same coxal bone with embedded fragment of bone projectile was not discussed in his chapter on paleopathology (*Roksandić 2000a*).

These instances have supported the conclusion that different results that Nemeskeri and I found in respect to both MNI and sex assessment stem from different weight accorded to the skulls and the postcranial skeleton in both of the analyses and also points out the benefits of detailed reconstruction of skeletons that was undertaken in the 1998 field season. More relevant information on the burial ritual is expected from the forthcoming analysis of skeletal representation and taphonomy of the material.

According to the building horizons, Srejović and Letica have divided the site into three chronological phases of the Mesolithic settlement (Vlasac I, II, and III) and one of the Neolithic (Vlasac IV). Since no human skeletal remains were associated with the lat-

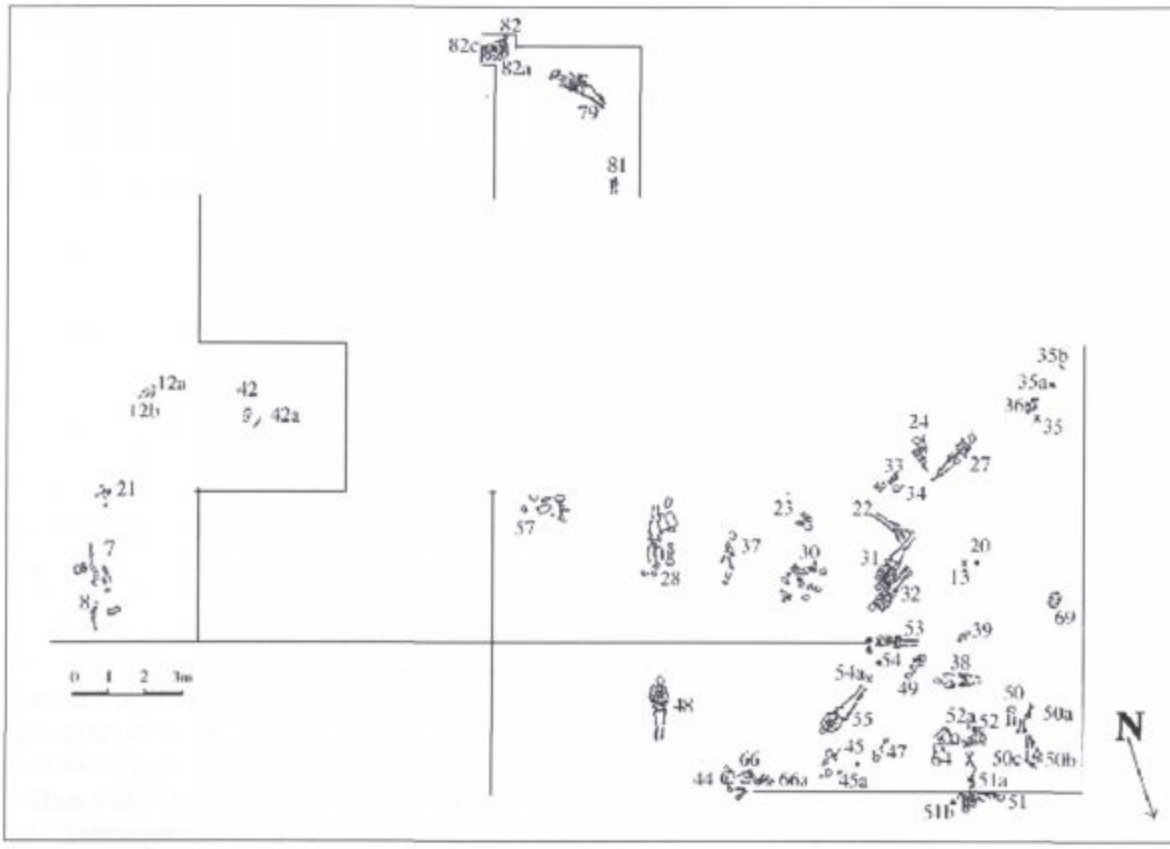


*Fig. 9. Vlasac West. Position of graves (*Adapted from Srejović and Letica 1978.Fig. 57*).*

ter, it will not be discussed in detail. Radovanović has observed significant changes in burial practices over time and has proposed a division of formal disposal areas into two chronological phases. Based on the published material, as well as field documentation (kindly provided by late Prof. Srejović, the principal investigator), she was able to distinguish an important change in burial practices that began to occur at the end of the Vlasac I but certainly were present in the Vlasac II phase (*Radovanović 1996a. 187–218*).

In the early Vlasac I phase she distinguishes a formal disposal area in the upstream Western Sector (Fig. 9) with parts of the Central Sector (Fig. 10) and a habitation area in the Eastern Sector. The situation changes in the Horizon II when habitations are clearly present on the border of the rocky plateau facing the river at both the Eastern (Fig. 11) and Western sector of the settlement. Burials are distributed along the whole settlement area. Some of the burials from Vlasac II are associated with the early and some with the later formal disposal areas.

However, both Vlasac I and II would belong to the Mesolithic pre-contact period and only Vlasac III would chronologically belong to the period when the contact with the Neolithic populations was possible. All of the cases where Radovanović could not certainly distinguish between the Vlasac II and III burials are treated as Mesolithic/Neolithic contact. However, a separate test was run with these individuals included in the Mesolithic group since contacts between Lepenski Vir and surrounding farming population(s) is least attested in Vlasac of all of the sites: no pottery was found in these layers, and all of the Pre-Balkan Plateau flint was explained as intrusive (*Srejović and Letica 1978; Kozłowski and Kozłowski 1982*).

Five ^{14}C dates (Tab. 6) derived from human skeletal remains are given in Bonsall *et al.* (*1997*) and they are well in accordance with Radovanović's (*1992; 1996a*) determination of the burials phases since only Grave 24 is determined as belonging to the Contact period.

Another set of dates was calculated on the basis of nitrogen and fluorine content (*Buczko et al. 1978*). The authors acknowledge that the content of nitrogen and fluoride is also dependent on climatic changes and therefore propose two different values for each of the skeletons. These values all fall within the range of 5250±100 to 5900±200 for the column

A and between 6250±150 and 7400±300 in the column B. They also provide a set of more probable dates based on the relative - archaeological chronology. Since the whole process depends on the archaeological data, these absolute dates are perceived as uninformative and are not discussed further.

All of the human skeletons from the site belong to the Mesolithic settlement. Human skeletal remains comprise 164 individuals from the 84 reported graves. This differs significantly from the 119 individuals reported by Nemeskeri (38% increase). These "extra" individuals are represented by very small cranial or postcranial fragments. No scattered human remains were reported among the faunal remains. The skeletal part representation varies from fragments of bones to whole skeletons. Of these, 45 were buried in single graves, 44 in 22 double graves, 13 graves contained remains of three individuals each (39); five graves had four individuals each (20); two graves contained remains of 5 individuals each (10); and one grave contained six individuals.

Adults represent the majority of the sample: 108 individuals or 66%. Young adults are represented by 21 individuals, and old adults by 40; for 47 of them it was possible only to state that they were adults. Of the 47 subadult individuals 26 are of neonatal (or perinatal) age (16% of the total sample or 56% of the subadult sample), one was a child between 2-5 years, 8 children were between 6-11 and 6 between 12-18 years old. For six of the subadult skeletons the age could not be determined. In nine cases it was not possible to determine if the individual reached adulthood. As with other samples from the series, the approach to age was very conservative and age was assigned in deliberately broad categories.

Positive sex determination was possible in 41 cases of the total adult sample (38%) of which 26 were determined as females and 15 as males. A further 16 were determined as possible females and 31 as possible males on the basis of robusticity. The larger number of determinable females could be due either to more elements (such as preauricular sulci) being significant to the female pelvic morphology or to a cultural agent. It will be discussed later with data on size and robusticity.

In keeping with the marking of the other sites, "extra" individuals within graves were given a grave number from existing documentation and publication and an additional in brackets.

According to the presented chronology the following 125 individuals are determined as Mesolithic precontact burials:

single burials: 7; 8; 10, 11; 13, 20; 25; 28, 30; 31; 32; 33; 34; 37; 38; 39; 40; 41; 44; 59; 61; 63; 68; 72; 79; 81; *double* burials: 9, 9(1); 12a, 12b; 19,

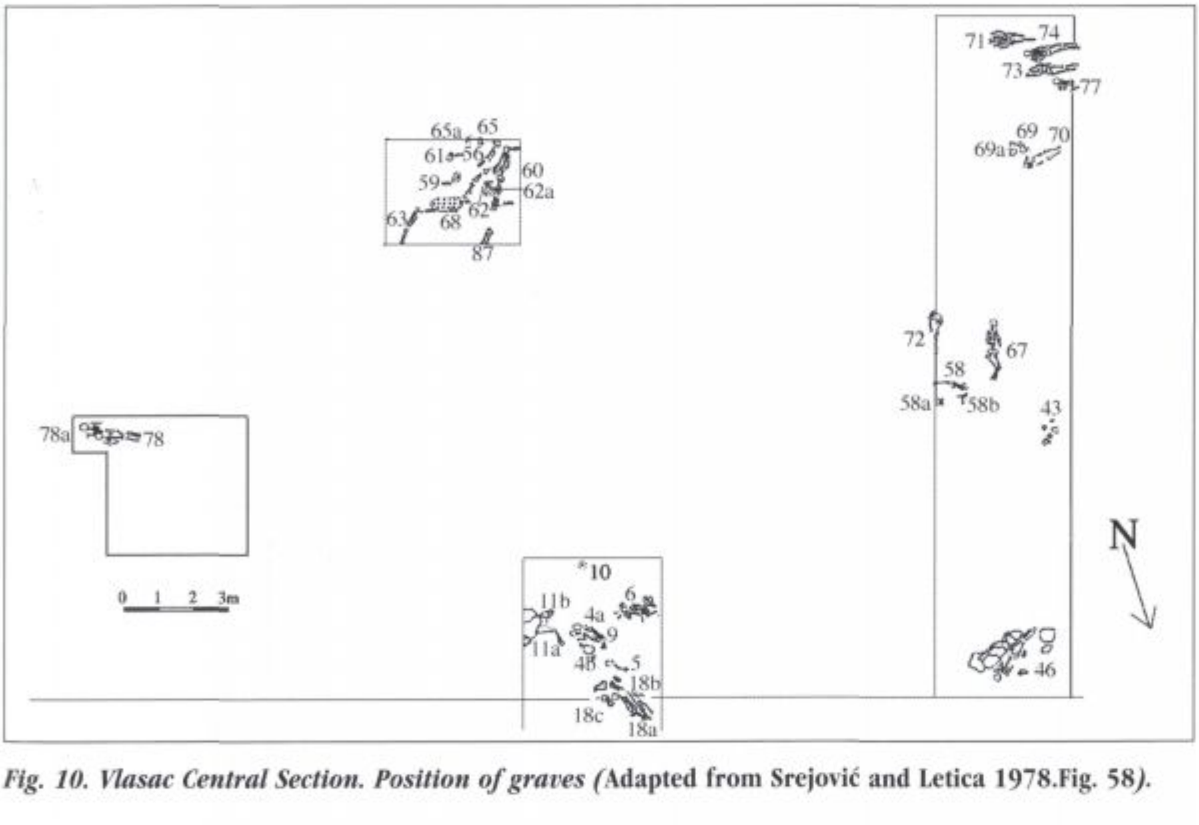


Fig. 10. Vlasac Central Section. Position of graves (**Adapted from Srejović and Letica 1978.Fig. 58*****).***

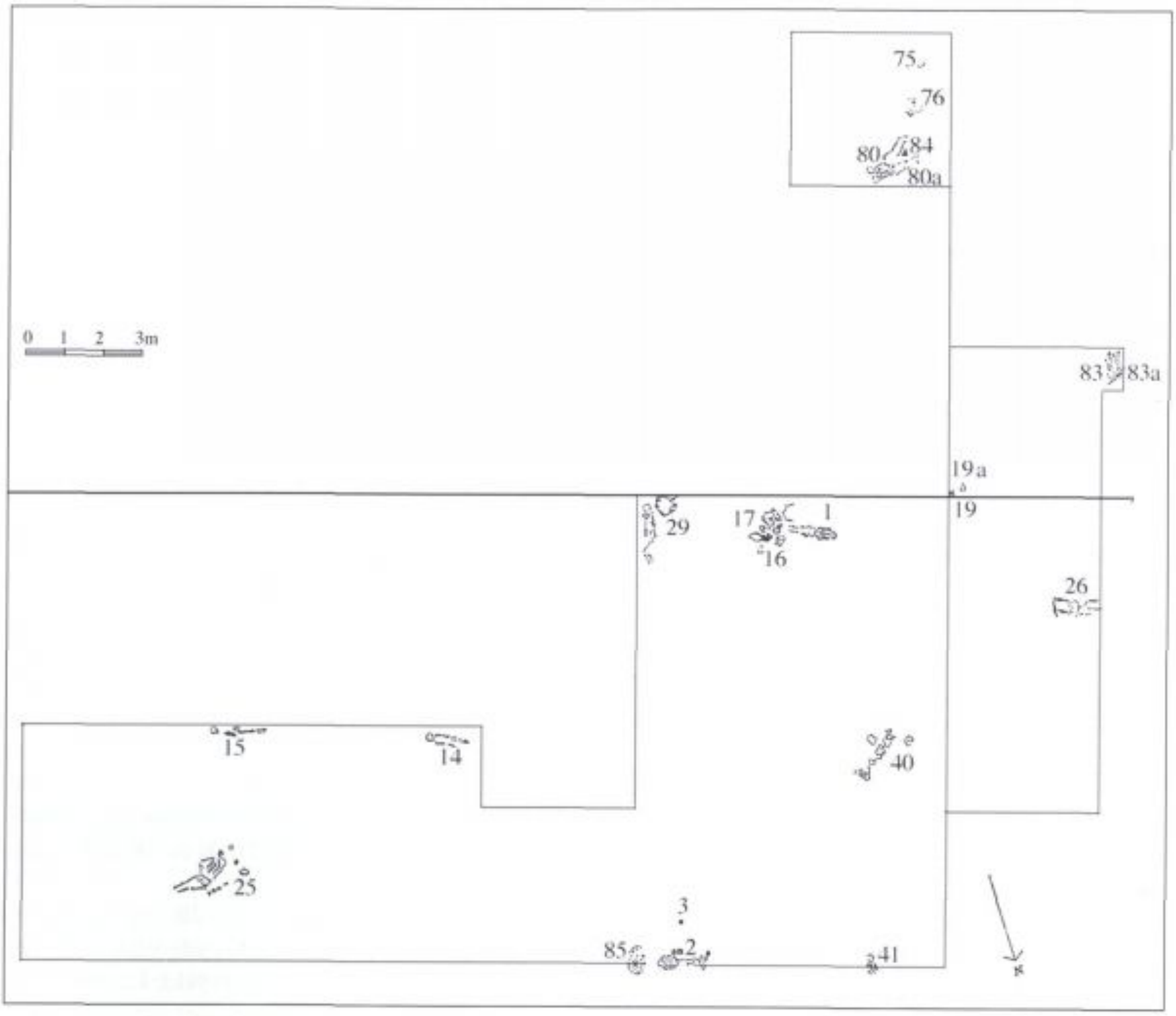


*Fig. 11. Vlasac East. Position of graves (*Adapted from Srejović and Letica 1978.Fig. 59*).*

19a; 35, 35a; 42a, 42b; 47, 47a; 48, 48(1); 53, 53(1); 56, 56(1); 57, 57(1); 60, 60(1); 62, 62(1); 66a, 66a(1); 80, 80a; 84, 84(1); *multiple* burials: 4a, 4b, 4b(1); 5, 5(1), 5(2); 6, 6a+6(1), 6(2); 18a, 18b, 18c; 21, 21(1), 21(2); 36, 36(1), 36(2); 45, 45(1), 45a+45(1); 49, 49(1), 49(2); 50, 50(1)+50a (1), 50a, 50a(2)+ 50b(1), 50a(3), 50b; 51, 51a, 51b, 51+51a+51b(1), 51+51a+51b(2); 52, 52(1), 52(2), 52(3); 54, 54(1), 54(2); 55, 55(1), 55(2), 55(3); 58, 58a, 58b; 64, 64a, 64b; 65, 65(1), 65a; 67, 67(1), 67(2), 67(3); 82, 82 (1)+82b, 82(2)+82c, 82(3), 82 (4)+82a; 83, 83a+83(1), 83(2), 83(3).

The following 35 individuals were assigned to the Mesolithic/Neolithic contact period:

single burials: 2; 14; 16; 17; 22; 23; 24; 43; 46; 75; 76; *double* burials: 15, 15(1); 27, 27(1); 70, 70(1); 71, 71(1); 73, 73(1); 77, 77(1); 78, 78a; *multiple* burials: 29, 29(1), 29a; 69, 69(2), 69a, 69(1)+ 69a(1); 74, 74(1), 74(2).

For the following four individuals it was not possible to determine chronological position:

single burials: 1; 3; *double* burials: 26, 26(1).

Vlasac figures prominently among Iron Gates Gorge osteological material with a thorough publication by

Skeleton number	Lab ID	^{14}C age BP	cal BC age 1σ	cal BC age 2σ
72	OxA-5824	10240±120	10317–9749	10482–9138
51a	OxA-5822	8760±110	7949–7585	8027–7537
83	OxA-5827	8200±90	7411–7039	7476–6824
54	OxA-5823	8170±100	7300–7033	7473–6771
24	OxA-5826	8000±100	7039–6655	7252–6562

*Tab. 6. Absolute dates for Vlasac (*from Bonsall et al. 1997.Tab. 6*).*

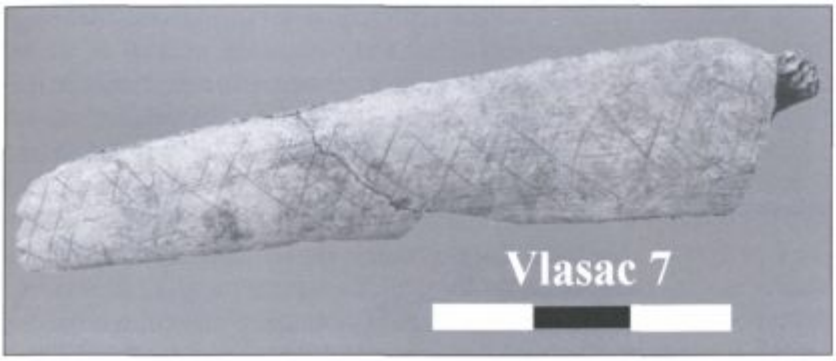


Fig. 12. Ornamented bone artefact found with human remains.

Nemeskeri and his colleagues (*Srejović and Letica 1978.Vol. 2*). Although there are discrepancies between current research and Nemeskeri's in the MNI and sex assessment, the basic cranial metric analysis is thorough and the postcranial metrics are improved only by the addition of reconstructed bones from the site.

3.5.4. Hajdučka Vodenica

This site is the only site on the right bank of Danube situated in the Lower Gorge and some particularities are therefore to be expected. This site is by far the most under-reported of Iron Gates Gorge sites, and apart from several articles published by Jovanović right after the excavation, in which Jovanović misinterprets the site as an Iron-Age locality, there is only one article on human remains from Hajdučka Vodenica. In this article Živanović (*1976a*) follows the archaeological assignment of the skeletons to either the Lepenski Vir culture or the Iron Age and claims that they are substantially different populations. However, neither the archaeological material, nor the human remains warrant such a sharp distinction between the two groups (*see Radovanović 1992; 1996a*). Živanović (*1976a*) has reported 10 skeletons washed away by Danube in the course of excavations, for which he has, from the photos, and drawings, assigned the sex and age in some cases (*Sic*!). Jovanović (*1984a; 1984b*) has dropped the Iron Age argument and Radovanović (*1992*) has shown that all the skeletons should be regarded as belonging to the Lepenski Vir culture alone and could be divided into two phases (*Radovanović 1992*). Jovanović distinguishes between Horizon I (a and b) and Horizon II (*Jovanović 1968; 1969*). In Horizon I, two superimposed building structures are discerned (Ia and Ib). A chamber tomb, to which most of the burials from the site belong, is assigned to Horizon II in the Central area. In the south-western area, only traces of burning are associated with anthropogenic layer of dark soil with no pottery finds, while horizon II has two levels of stone constructions associated with numerous pottery finds (Fig. 13).

Radovanović's interpretation of the stratigraphic sequence associates the "habitation" in the central area with the burials in the Chamber tomb. The early habitation floor Ia and the later Ib floor within the same location (but shifted slightly towards the back of the site) of the central space are divided by 0.80 m of cultural debris. The earliest level of graves within this debris is noted as Ib1 by Radovanović (signifying its pertaining to the early phase of the Ib horizon. Jovanović's layer Ib (the later habitation floor is noted as Ib2 by Radovanović and found to be synchronous with the chamber tomb that Jovanović denotes as Horizon II. The later level of the graves in the tomb (above the floor) is denoted as Ib3. Following synchronisation (Tab. 7) for the whole of the settlement and formal disposal area was proposed.

Within the proposed framework, all of the burials from Hajdučka Vodenica would fit within the Mesolithic/Neolithic contact period. The meaning of the Chamber tomb and the two levels of the associated habitation are still very hard to discern. More thor-

layer	Central Area	South-western Area
II		two levels of the stone construction containing pottery of the Starčevo type
Ib3	later horizon of the chamber tomb	late level with rectangular hearths and the formal disposal area, pottery finds more frequent (1b1–3)
Ib2–Ib3	chamber tomb dug in – early burials	
Ib2	later habitation floor	
Ib1	early burials	
Ia	early habitation floor	early level of stone construction with sporadic pottery finds

Tab. 7. Synchronisation of Hajdučka Vodenica by areas of excavation. (*Adapted from Radovanović 1996a*).

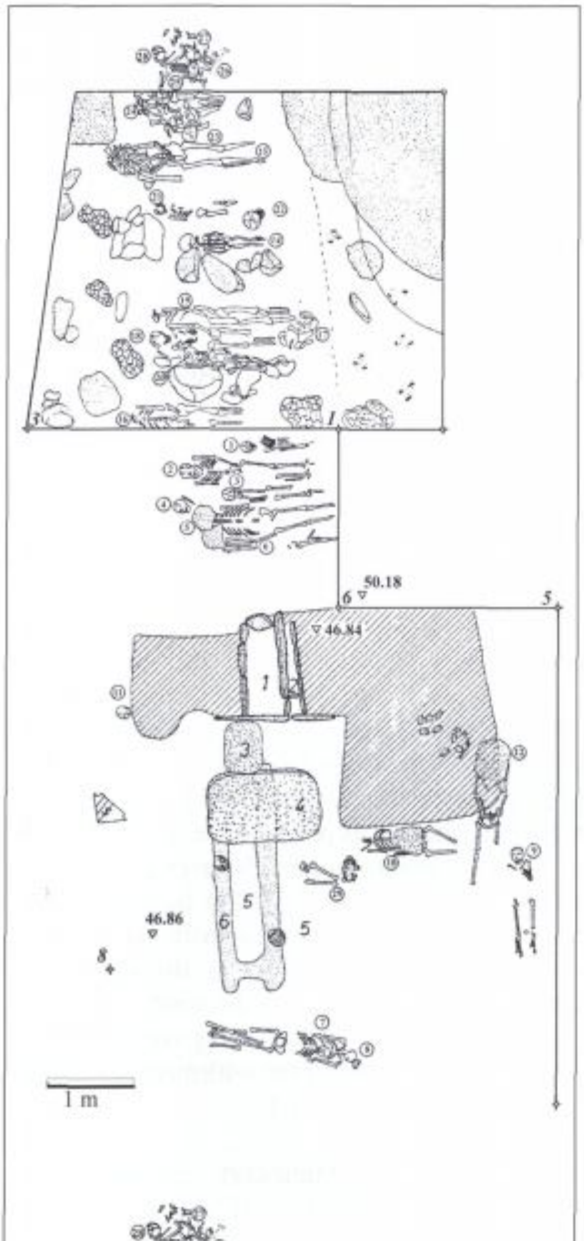


Fig. 13. Hajdučka Vodenica. Southwestern Area featuring two layers of hearth and architectural construction and burials. Note that the burials in the "burial chamber" (background) are in two levels. Unpublished site plan courtesy of B. Jovanović.

ough analysis of the material present within the two is needed. In the light of the importance of game and small amount of fish it becomes even more crucial to offer a detailed study of the spatial distribution of different finds and artefacts within the site. Unlike the other sites, the graves show remarkable uniformity in the burial position and even orientation. This uniformity, as well as the restricted and well respected space for the burials, is well in accordance with the (comparative to other sites) short time span of the necropolis and of the chamber tomb.

The skeletal representation ranges from small fragments of skulls and postcranial remains to whole skeletons. For the 32 graves recorded on the site the MNI was calculated at 46. This MNI includes one individual for all of the 10 missing graves. Since Živanović did not pay attention to small fragments of secondary buried individuals these graves cannot be ascertained as single graves and therefore will be excluded from further discussion. Eight individuals were buried in single burials, six in three double graves, two graves had three individuals each, and three graves had four, five and seven individuals respectively:

missing burials: 1; 2; 3; 4; 5; 6; 7; 9; 10; 12; *single* burials: 8; 11; 16; 21; 22; 30; 31; *double* burials: 14, 14(1); 29, 29(1); 33, 33(1); *multiple* burials: 15 m, 15 s, 15s(1); 17/17-20(3)/; 18/17-20/; 19/17-20(2)/; 20/17-20(4)/; 17-20(1); 20; 20(1); 23+24+25(1), 23+24+25(2), 23+24+25(3), 23+24+25(4), 23+24+25(5); 26+27+28(1), 26+27+28(2), 26+27+28(3), 26+27+28(4); 32, 32(1), 32(2).

Of the 36 skeletons that were examined, 27 were adults (75%): 9 of them old, 2 young and for 16 age could not be determined with precision. Among children, there are no newborns or children below 5 years of age, only two children between 6-11 years and 4 in 12-18 years category. It was not possible in three cases to determine if the individual had reached adulthood at the time of death.

Only in seven cases of the 27 adults, was sex determination possible on the basis of pelvic remains: one individual was female and six were determined as male. A further four individuals were determined as possible females and 8 as possible males. In eleven cases, it was not possible to determine sex on adult remains.

All four sites, as is evident from the above descriptions, present a different set of features, but within the same cultural tradition. Their function, as we have previously noted, is far from clear. New research on the specifics of mortuary ritual, settlement organisation, cognitive and symbolic aspects of the art, is needed in order to understand the interaction of these discernible features with social and ideological aspects of Lepenski Vir-Schela Cladovei complex. This research aims at discerning a possible regional pattern of biological interaction between hunter-gatherers and neighbouring farmers that can provide a starting point for understanding their more complex social interactions.

4. METHODS

Two types of data are considered in this research: cranial and postcranial non-metric traits and postcranial size/robusticity data. They were selected on the basis of the following:

- Craniometric analyses have already been reported for most of the material and different conclusions were offered by Nemeskeri, Mikić, Zsoffmann and others primarily for Lepenski Vir and Vlasac. It was felt that a comparison of the results from the study on non-metric traits with previously published results based on cranial metrics would be beneficial both as an independent test of current understanding of population interaction and evolution in the Iron Gates Gorge Mesolithic and/or in order to provide additional interpretations for the phenomena.
- The material from the four sites comprises individuals with unequal skeletal representation. This has resulted in an important reduction of sample size for metric analysis and also possible selective bias. Namely, skeletal representation in the Iron Gates Gorge is to a great extent due to different mortuary practices that include whole skeletons as well as small fragments of secondarily disposed individuals (*Roksandić in prep.*). The disposal practices are not well explained and body part representation has not been compared to chronological sequences, although an attempt from the published literature is made both by Radovanović (*1992; 1996a*) and Chapman (*1993*). In the light of this phenomenon, the selection of fairly complete skulls for analysis could result in a systematic bias towards a segment of the population. Secondarily disposed skeletons without the skull, or primary burials from which the skull was taken away and re-deposited in a different, thus far unknown location would not figure in the analysis. It is not difficult to envisage, although it need not necessarily be correct, that a supposedly different incoming population could have had different treatment at death, resulting in either over or under representation in the total number of examined individuals. Although non-metric analysis cannot pretend that the population examined is representative of the living population of the site, as every cemetery population is necessarily biased, it is more evenly distributed, and the bias is not unidirectional.
- Since dental traits reflect genetic make-up of an individual (and a population) much more unambiguously than other elements, their examination was one of the logical choices. However, during the 1996 season, it was established that the improper curation of the specimens has resulted in severe damage to the enamel. In order to maximise the number of observations, a thorough conservation was needed for most of the teeth. In the restricted time and finances of the project this was deemed impractical. Provisions to reduce further damage as well as some conservation and reconstruction is underway and should help bring these traits forward in a complementary study.
- Although there is an ongoing discussion amongst anthropologists about the ability of different analyses to establish relationships among skeletal samples, a paired study of analyses of diverse non-metric traits and cranial measurements demonstrates that the former are more powerful in this respect (*Jackes et al. 1997*).
- However, since non-metric variants could prove to be inconclusive, an independent measure of differences between chronological and site units was deemed necessary. Size and robusticity differences between samples - observable throughout the Iron-Gates material - provided a possible other measure, independent of the non-metric traits, for both secular trends, environmental - nutrition based changes and population differences.

A combination of these two methods covers a large area of possible explanation for observed changes and, since there is no indication that they are dependent on each other, they could show different patterning and thus provide firmer grounds for explanation.

4.1. Non-metric traits analysis

4.1.1. Background

In the literature, nonmetric skeletal variants are described as discrete, discreta, discontinuous, anomalies, atavisms, all-or-none attributes, minor variants, nonmetric characters - emphasising discontinuity; or quasi-continuous traits, epigenetic polymorphisms, threshold characters - emphasising underlying continuity (*Saunders 1989.96, Tab. 1*). The term nonmetric minor anatomical variants (further non-metric traits) that distinguishes them from general morphological features, seems to be the most appropriate as it is purely descriptive, implying neither scoring procedure nor their biological background.

There are more than 200 variants observed on the skull alone (*Hauser and De Stefano 1989; Ossenberg 1976*) and almost as many on the postcranial skeleton (*Saunders 1989*). They have been recorded as early as 1670 by Kerckring as skeletal anomalies, and only in the XIX[th] century were they employed in early studies of comparative anatomy and phylogeny (*Antouchine 1878; Bertelli 1892; Schultz 1919*). Although familiar occurrence was reported as early as 1893 by Shepherd (*1893*), it was not until the studies by Gruneberg (*1952*) and Berry and Berry (*1967*) on mice, that these traits were perceived as relevant for studying population affinities (*Hauser and De Stefano 1989*). After an initial phase of confidence in the method (*Berry and Berry 1967*), methodological studies criticising a number of underlying problems with these early studies have brought down the initial enthusiasm and it was suggested that their value is inferior to that of metric analysis in examining population distance (*Corruccini 1974; 1976; van Vark and Schaafsma 1992*). Assumptions that there is no side, sex and age correlation, and interrelation between traits, were soon reviewed and criticised (*Ossenberg 1969; Suchey 1975*) and it was shown that environment plays an important role in trait manifestations.

Gruneberg (*1952*) has shown that single gene mutations in mice could produce a number of these traits, but also those traits could reach high frequencies in normal mice of certain inbred strains. He also observed that there are no strict correlations between parents and offspring, indicating that the traits did not follow simple Mendelian patterns of inheritance. Hauser and De Stefano (*1989.5–10*) accept the model of "threshold character" proposed by Falconer (*1965*) in relation to the pathological conditions as the underlying theoretical basis for all of the characters. The liability (as in the context of disease) to develop a trait is normally distributed, and depending on the position of the individual's inherited tendency to develop the character relative to the threshold, the character may or may not be expressed. The genes involved are multiple genes with small additive frequencies. Threshold models permit a number of other environmental and developmental factors to be included in the determination of the trait's expression and allow for the observed gradients in some of the traits. An individual situated just below the threshold in one environment may be pushed over it in another (*Hauser and De Stefano 1989.7*) which reinforces the population specific character of the frequencies of trait expressions. The proportion of total variance attributed to the additive effects of genes, known as the heritability of the trait, was calculated from the study of the frequency of the condition in a series of related individuals of known sex and age (*Sjøvold 1984*) and was shown to be significant although low. However, any attempt to relate individuals within a series to one another failed to perform, because of this underlying complex genetic basis of the traits (*e.g. Crubezy 1991*).

4.1.2. Choice of characters

The choice of characters for the present study is based on a number of characters for which low environmental influences were suggested by Saunders (*1989*) and Buikstra and Ubelaker (*1994*) as well as some additional characters observed as present during the first field season on the Iron Gates Gorge material itself (*sutura squamo-mastoidea* and *tuberculum marginale*). The original list comprised the following traits for the skull (Tab. 8).

Of the total of 66 variables for the skull, 29 paired (cranial traits that could be recorded bilaterally) and eight axial (that had only sagittal expression) were recorded. Procedures for recording followed *Standards* (*Buikstra and Ubelaker 1994*) where applicable and Hauser and De Stefano (*1989*) in all other cases. Most of the traits were recorded on a scale rather than present or absent in order to allow more flexibility in the final analysis. However, they are treated as discrete in the statistical analysis. Since Buikstra and Ubelaker (*1994*) offer very little in terms of postcranial non-metric traits, a list of postcranial traits adapted from Czarnetski (*1972b*), Czarnetski *et al.* (*1985*) and Saunders (*1978*) was added (Tab. 9). Only one of the characters was not paired (unfused *processus odontoideus*). The remaining 21 could be observed on both left and right side, which totalled 43 variables for the postcranial skeleton.

4.1.3. Reducing the number of variables

A great number of variables is not only cumbersome in terms of statistical analysis but can also act to reduce the observed difference between subsamples. A more restricted number of appropriately chosen variables can distinguish better between populations (*Krenzer 1996*). Although Krenzer's primarily goal was to distinguish between major geo-populations of Eurasia, this statement is also valid for more restricted geographic samples (*Molto 1983*). Given the preservation of the material, many of the traits that were initially recorded failed to allow sufficient numbers of observations. Therefore, reduction of traits was necessary for both theoretical and practical reasons.

1st step – Only adult skeletons from all of sites were taken into consideration since the occurrence of non-metric traits in subadults can be ambiguous. For

CRANIAL CHARACTERS WITH CODE AND SCORING SCHEME

character	CODE	scoring
metopic suture	met	absent/ partial/ present
supraorbital notch	snl/snr	absent, <1/2, >1/2, multiple notches
supraorbital foramen	sfl/sfr	absent/ present/ multiple
marginal tubercle tuberculum marginale	tzl/tzr	present/ absent
infraorbital suture	isl/isr	absent/ partial/ complete
multiple infraorbital foramina	mifl/mifr	absent/ internal division two foramina/multiple
zygomatico-facial foramina	zffl/zffr	absent/ large/ small/ multiple
parietal foramen	pf	absent/ parietal/ sutural
epipteric bone	ebl/ebr	absent/ present
coronal ossicle	cbl/cbr	absent/ present
bregmatic bone	breg	absent/ present
sagittal ossicle	sag	absent/ present
apical bone	apic	absent/ present
lambdoid ossicle	laml/lamr	absent/ present
asterionic bone	astl/astr	absent/ present
ossicle in occipito-mastoid suture	occml/occmr	absent/ present
parietal notch bone	parnl/parnr	absent/ present
inca bone	inca	absent/ complete single/ bipartite/ tripartite/ partial
condylar canal	concl/concr	non patent/ patent
divided hypoglosal canal	hypl/hypr	absent/ partial internal/ partial within canal/complete internal/ complete within canal
flexure of superior sagittal sulcus	flex	right/ left/ bifurcate
foramen ovale incomplete	foil/foir	absent/ partial/ no foramen
foramen spinosum incomplete	fsil/fsir	absent/ partial/ no foramen
pterygo-spinous bridge	psbl/psbr	absent/ trace/ partial/ complete
pterygo-alar bridge	pabl/pabr	absent/ trace/ partial/ complete
tympanic dehiscence	tdl/tdr	absent/ foramen/ full defect
auditory exostosis	audtl/audtr	absent/<1/3/ 1/3–2/3/>2/3
suprameatal spine and depression	pael/paer	large s no d/ no s and deep d / small s and no d/ small s small d/ large s small d/ large s deep d
mastoid foramen location	mffl/mffr	absent/ temporal/ sutural/ occipital/ sutu. and temp./ occ. and temp.
mastoid foramen number	mfnl/mfnr	absent/ 1/ 2/ >2
sutura squamo mastoidea	ssml/ssmr	present/absent
mental foramen	mefl/mefr	absent/1/ 2/ >2
mandibular torus	matl/matr	absent/ trace/ moderate/ marked
maxillary torus	maxl/maxr	absent/ trace/ moderate/ marked
palatine torus	pal	absent/ trace/ moderate/ marked
mylohyoid bridge location	mhbll/mhblr	absent/ near mandibular foramen/ center of grove/ both with hiatus/ both no hiatus
mylohyoid bridge degree	mhbdl/mhbdr	absent/ partial/ complete

Tab. 8. Cranial traits examined in the study (l = left and r = right for paired bones).

POSTCRANIAL CHARACTERS WITH CODE AND SCORING SCHEME		
character	**CODE**	**scoring**
atlas bridging posititon	abpl/abpr	absent/ lateral/ posterior
atlas bridging degree atlas	abdl/abdr	absent/ partial/ complete
facies articularis condilaris partitum	faal/faar	absent/ partial/ complete
dens axis isolated	denai	fused/ unfused
fovea costo-clavicularis deep	fccl/fccr	absent/ present
suprascapular foramen or notch	ssfl/ssfr	shallow/ semicircular / >2/3 notch/ foramen
accessory acromial articular facet	aaafl/aaafr	absent/ present
unfused coracoideus	uncol/uncor	fused/ unfused
glenoid fossa extension	gfel/gfer	absent / present
ligament teres in cavitas glenoidalis	ltcgl/ltcgr	absent / present
perforatio fossae olecrani	pfol/pfor	absent/ small perforation/ multiple sp/ 1-2mm/ 2-5mm/ > 5mm
supratrochlear spur	stsl/stsr	absent/ present
fossa bicipitis radii	fbrl/fbrr	absent/ present
unfused processus olecrani	upol/upor	fused/ unfused
fossa faciei lunatae	ffll/fflr	absent/ present
Allen's fossa	alfl/alfr	absent/ present
third throcanter	ttl/ttr	absent/ present
Poirier's facet of extension	pofl/pofr	absent/ present
Vastus notch	vnl/vnr	absent/ <60°/ 60-90°/>90°
Squatting facets on distal tibia	sfl/sfr	absent/ present
Squatting facets (talus) superior surface, anterior to the articular facet for the tibia	sftl/sftr	absent/ present
Shape of the talar articular surface on calcaneus	ctasl/ctasr	discrete facets/ anterior and middle joined/ all 3 joined

Tab. 9. Postcranial characters examined in the study (l = left and r = right for paired bones).

example, unfused *processus olecranii* can be a non-metric trait in adults, while in subadults it is associated with a certain stage of development of the skeleton. This has reduced the total number of individuals examined from 438 (MNI) from all four sites to 259 (MNI) adult individuals.

2nd step – Since the chance of purely random significant correlation occuring on the tested samples becomes greater with the number of correlation tests performed (*Tallig pers. comm.*), the first step in the procedure was to remove all of the variables that could not be observed (both as absent or present) on at least 10% of the examined adult sample. This resulted in the elimination of the following variables with the number of possible observations in brackets: ISL (20), ISR (23), MIFL (18), MIFR (20), CONCL (25), CONCR (27) FOIL (7) FOIR (12), FSIL (13) FSIR (8), PABL (17), PABR (16), TDL (4) TDR (12) in cranial traits and ABPL (12), ABPR (9), ABDL (12) ABDR (9), FAAR (12), DENAI (24), SSFL (4), SSFR (2), AAAFL (11), AAAFR (11), UNCOL (27), UNCOR (18), GFER (26), FFLL (21), FFLR (16), in postcranial, or a total of 32 variables.

3rd step – In the studied population, a number of traits had very low incidence of positive values across the sample (less than 5). As, depending on the sample size, a small absolute number of occurrences can produce biased results, the following 16 variables were excluded even before their frequencies within subpopulations were examined: MET (2), EBL (0), EBR (1), CORL (2), CORR (2), BREG (1), OCCML (1), OCCMR (3), INCA (4), GFEL (0), STSL (4), STSR (4), FAAL (2), FBRL (2), FBRR (3), FCCL (4), FCCR (2), UPOL (0), UPOR (0).

4th step – Of the remaining 55 variables another group of characters, those with low overall frequencies, were checked against chronological and spatial subpopulations in order to assess their overall variability. If the traits show low variability within the population, they will tend to reduce the interpopulation difference in statistical analysis, as they have a negative, reducing effect on the variance of the MMD (*Sjøvold 1977; Molto 1983.113*). Sjøvold (*1977*) recognises two types of low variability traits: those that have reached fixation in every sample studied, and others that have very low uniform incidence in any set of population samples.

Rather than using the χ^2 or Fisher's exact between samples test to exclude the variables for which the significant difference is not obtained in at least one pairwise comparison (*as suggested by Sjøvold 1977*), the empirical results that Molto (*1983.114*) reported for an Ontario Iroquois sample were applied. In Molto's study (*1983.115*) the largest range of frequencies among the traits that had low variability was 7.1 (for example, 0.0% in one sample to 7.1% in another). Molto has excluded these traits from further consideration and kept those with minimum range in any of the samples equal or greater than 10% (e.g. 21% in one and 31% in another). By using this observation as a rule of thumb in the present study, rather than increasing the possibility of finding statistical significance (where there might be none) through a large number of tests performed, following traits were determined as having low overall variability and excluded: ASTL, (14.29–20), ASTR (17.86–21.74), PARNL (8.5–16.67), PARNR (8.7–14.29), PAEL (0.00–6.25) and PAER (0.00–3.03).

5th step – The following variables were excluded because of the high inter or intra observer error: MFLL/MFLR, MFLN/MFLR, MHBLR/MHBLL, calculated from the observations recorded in 1996 and those recorded in the 1998 field season on a randomly chosen subsample.

6th step – The Fisher exact test of significance was performed in order to check for possible correlation of traits with sex. Only one variable pair was found to be potentially correlated with sex: the mandibular torus (MATL/MATR). In the published literature, there is no definite pattern of preference according to sex, but the general trend of predominance in females is reported (*Hasuer and de Stephano 1989 and quoted literature*). The trait was excluded from further consideration.

7th step – Since the number of variables thus obtained was still sufficiently large and in view of the poor preservation of the sample, it was felt that recording frequencies in individuals rather than sides, as well as pooling sides, would result in reducing bias, especially in the very restricted Neolithic sample. Tests of side correlation were performed on all of the pairwise traits. The ones that showed correlation were excluded. In doing so the risk of increasing the probability of false correlation was ignored, as potential benefits in increasing the number of observations outweighed the concerns.

8. Remaining traits – Of the remaining 26 traits, further comparisons have eliminated coronal ossicle (No. 7 on the list of traits) because of very low variation (0–2.86%) in frequency. Traits that had less than 9 observations on left and right side combined in any of the subsamples (see further discussion on the sides recording of the traits) were also excluded. Only 17 traits that were used in the analysis are described in detail and their recording presented here. These are presented in Table 10. As can be seen only two traits of the postcranial skeleton are included in the final analyses: the septal aper-

trait name – common	Latin	code	trait no.
Marginal tubercle	*tuberculum marginale*	(TZ)	1
Squamomastoid suture	*sutura squamomastoidea*	(SSM)	2
Supraorbital notch	*incisura supraorbitalis*	(SN)	3
Supraorbital foramen	*supraorbital foramen*	(SF)	4
Zygomatico facial foramen	*foramen zygomatico-faciale*	(ZFF)	5
Parietal foramen	*foramen parietale presens*	(PF)	6
Coronal ossicle		(COR)	7
Lambda ossicle		(LAM)	8
Auditory torus	*torus auditivus*	(AUDT)	10
Mental foramen	*foramne mentale*	(MEF)	11
Maxillary torus	*torus maxilaris*	(MAX)	12
Mylohyoid bridge	*ponticulus mylohyoideus*	(MHBD)	13
Septal aperture	*perforatio fossae olecranii*	(PFO)	15
Third trochanter	*trochanter tertius*	(TT)	17
Apical bone		(APIC)	23
Inca bone	*os inca*	(INCA)	24
Palatine torus	*torus palatinus*	(PAL)	26

Tab. 10. Traits used in various combinations in the final analyses. Sides pooled.

ture (No. 15) for the humerus and the third trochanter (No. 17) of the femur. All other traits had to be excluded due to poor preservation of the relevant areas of the bone, especially in the Neolithic period. Therefore, inclusion of postcranial metrics seems even more complementary to the analysis of non-metric traits.

4.1.4. Description of traits and scoring procedures

The following description and discussion of traits relies largely on Hauser and de Stefano (*1989*) and quoted literature.

Marginal tubercle (No. 1) (Fig. 14): Hauser and de Stefano (*1989.226–230, Pl. XXXII, Fig. 36*) - This feature is differently known as *tuberculum marginale, processus marginalis, apophysis pyramidalis, processus Sömmeringi.* or *tuberculum zygomaticum.* It is a tubercle or a projection on the temporal border of the frontal processus of the zygomatic bone. This feature was observed as early as XIXth century and Luschka (*von Luschka 1869 quoted in Hauser and De Stefano 1989*) ascribed its formation to the insertion of the temporal fascia. Although no specific studies on the time of onset of the formation are known, it is observed in newborns. No inheritance studies have been carried out so far. The occurrence of the trait is symmetric. Perizonius (*1979*) has found it to show, on the largest European sample studied this far, a slight preponderance in males (36.7% compared to 30.0% in women). No correlation with sex was observed in the Iron Gates Gorge sample. There are not enough data on frequencies in different populations to allow comparisons. It seems to be a fairly common trait in European populations (*Perizonius 1979*). In order to determine the presence of a marginal tubercle, "a line is drawn from the most temporal point of the frontozygomatic suture, tangential to the deepest point of the curve on the superior temporal edge of the zygomatic bone" (*Hauser and De Stefano 1989.227*). This is done by using a small transparent ruler. If a part of the frontal process projects beyond the margin of the ruler, a marginal tubercle is present. The trait was coded as present or absent without distinguishing finer categories proposed by Hauser and De Stefano (*1989*).

Squamomastoid suture (No. 2) (Fig. 15): (*Hauser and De Stefano 1989.206–207, Fig. 32*). Known also as: *sutura squamomastoidea, sutura (fissura) mastoidea squamosa, sutura petrosquamosa*, mastoid notch. The junction between the anterior part of the mastoid process, characterised by a smooth surface, and the posterior part roughened by muscle insertions, presents a suture in newborn and early childhood. If this suture, or parts of it, persist in the adult, it is recorded as a nonmetric variant. No genetic studies have been reported to date. There is not

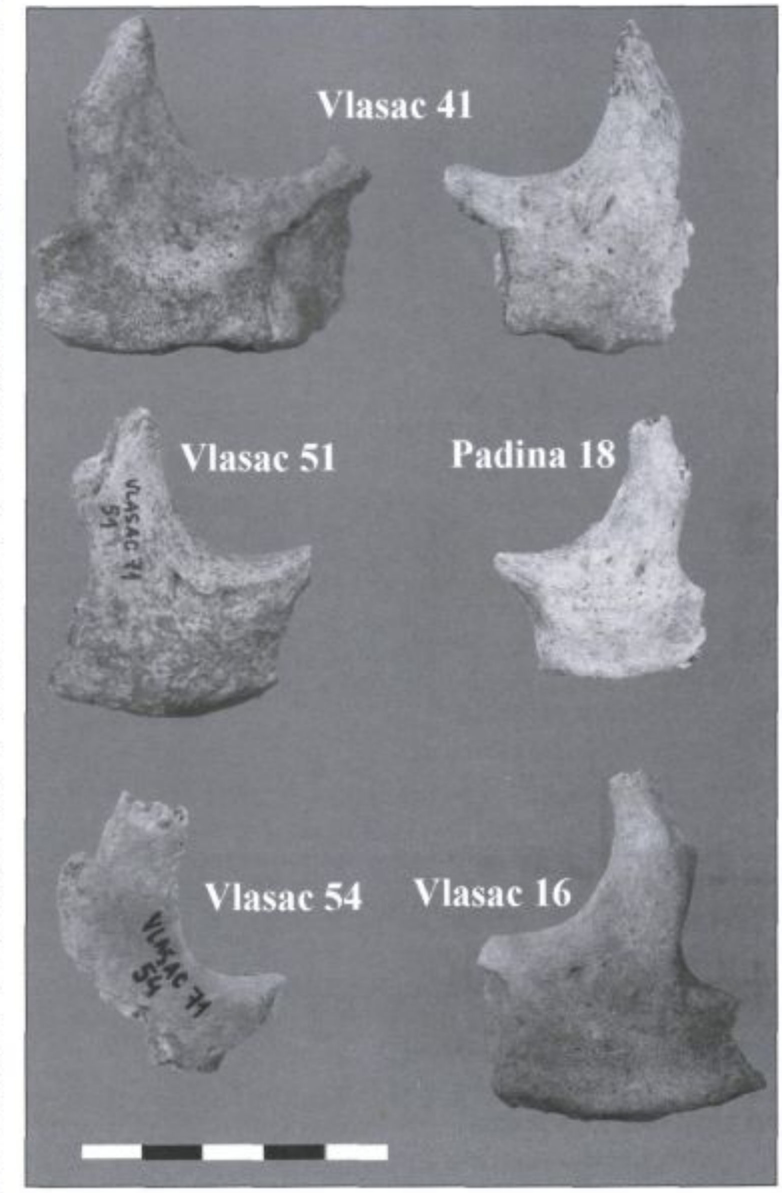


Fig. 14. Different expressions of the marginal tubercle.

Fig. 15. Squamomastoid suture. Lepenski Vir 26.

enough information on population incidence of the trait.

Supraorbital notch (No. 3) and ***Supraorbital foramen*** (No. 4) (Fig. 16): (*Hauser and De Stefano 1989.50–58, Fig. 10 Pl. VIII*). Supraorbital notches are also known as supratrochlear notch, *incisura supratrochlearis*, supraorbital medial notch, *incisura supraorbitalis medialis*, frontal notch, *incisura frontalis*, *sulcus supraorbitalis*, supraorbital foramen incomplete, supraorbital lateral notch, *incisura supraorbitalis lateralis*, *incisura supraorbitalis*. Supraorbital foramen is also known as: *foramen supratrochleare*, trochlear foramen, supratrochlear canal, *foramen supraorbitale mediale*, supraorbital notch closed, medial supraorbital canal, *canalis supraorbitalis*, frontal foramen, *foramen frontale*, *foramen supraorbitale laterale*, accessory foramen, supraorbital lateral canal, *canalis supraorbitalis lateralis*, *canalis supraorbitalis*. The supraorbital margin of the orbit is formed entirely by the frontal bone, which in this region might show either notches or foramina or both in varying positions and numbers, and of varying size. The notches may have blurred or acute margins. The foramina correspond to external orifices of canals perforating (piercing) the margin of the orbital roof. Care should be taken not to confuse these with external orifices or nutrient canals or large porosities. Simply stated they have to pierce through the bone to be recognised as such (*Hauser and De Stefano 1989. 51, Pl. VIII*). In the study of prematurely born infants the notches and foramina were observed as early as the 25th gestation week (*Hauser and Bergman 1984*). There is an observable increase in canals and formation of a second notch later in development. However, age dependency ceases in adulthood and these traits remain constant throughout the adult years (*Berry 1975; Perizonius 1979*). The early manifestation of these traits suggests a strong genetic base. Sjøvold (*1984*) recorded presence and absence of the trait in a number of skeletons of families of known sex, age and origin, and came to the same conclusion. The fact that both the shape and the number of notches and canals vary suggests both different growth patterns and different morphology of nerves and vessels. The number of canals can relate to bifurcation modalities i.e. a nerve can bifurcate before it enters the supraorbital margin or after and will produce a different result. No statistically significant differences were observed between males and females and there is apparently no side preference (*Dodo 1987; Mouri 1976; Hauser and De Stefano 1989*). There seems to be a general increase in frequency between puberty and adulthood (*Berry 1975; Cesnys 1982; Hauser and De Stefano 1989; Perizonius 1979*). There is a number of scoring procedures for these traits. Hauser and De Stephano (*1985; 1989*) distinguish supratrochlear, medial and lateral notch, as well as the supratrochlear foramen as a separate trait, noting the number of occurrences. In the present study no distinction was made between trochlear, medial and lateral supraorbital notch (lateral was not encountered). Supratrochlear and medial supraorbital notches are easily confounded and they differ more in the degree and position than in position alone, and therefore it is likely that a medial supraorbital notch with less than half of the structure occluded by spicules can be confounded with a supratrochlear notch by different observers, as can be seen from both the diagram and the photos of the traits provided by Hauser and De Stefano (*1989.Fig. 10, 54, Pl. VIII c, 52*).

Following Buikstra and Ubelaker (*1994*), the distinction was made between notches and foramina and

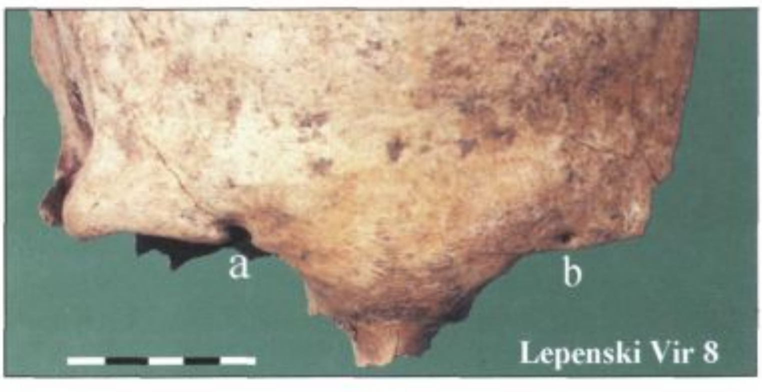


Fig. 16. Supraorbital notch (a) and foramen (b). Lepenski Vir 8.

the coding was done in the following manner: Supraorbital notch: values: *0* - absent; *1* - present < 1/2 occluded by spicules; *2* - present > 1/2 occluded by spicules; *3* - present degree of occlusion unknown; *4* - multiple notches; *9* - unobservable. In the final analysis 0 = absent and 1, 2, 3, 4 = present. Supraorbital foramen: values: *0* - absent; *1* - present; *2* - multiple foramina; *9* - unobservable. In the final analysis 0 = absent and 1, 2 = present.

Zygomatico-facial Foramen (No. 5): (*Hauser and De Stefano 1989.224-6, Fig. 35*). Also known as *foramen zygomatico-faciale*, zygo-facial foramen. On the facial surface of the zygomatic bone one or more foramina are usually present. Rarely, however, this foramen is absent. Generally they appear 5-8 mm below the orbital border, but may vary significantly in position. Also, multiple foramina may occur. These foramina represent the external aperture of a canal whose internal orifice is situated in the orbit. The numbers of the former and the latter need not correspond. Sjøvold (*1984*) reported a low heritability estimate for the absence of the foramina. Significant difference between sexes with higher incidence in females was reported by Cesnys (*1982*), and Corruccini (*1974*), others have noted only tendencies for higher incidence in either males or females. No sex correlation was found in this study. Incidences vary from 8.6% in Modern Japanese (*Mouri 1976*) to 99.1% in medieval Serbian populations (*Živanović 1979a*). Scoring differs among different authors. Berry and Berry (*1967*) note absence only, while Hauser and De Stefano (*1989*) suggest a more detailed scheme including (a) number: absence, one, two, three or more; (b) size of the largest: small = 0.3 mm wire enters, medium = 1 mm wire, large = 1.2 mm wire, excessive = 2 mm wire; (c) position: on the corpus, on the frontal process. Buikstra and Ubelaker (*1994*) suggest the following scheme: *0* = absent, *1* = 1 large, *2* = 1 large plus smaller, *3* = 2 large, *4* = 2 large plus smaller, *5* = 1 small, *6* = multiple small.

In the following study only the number of foramina was recorded in the following manner: value *0* - absent; *1* - one small; *2* - one large; *3* - two; *4* - more than two. In the final analyses 0 = absent 1, 2, 3 and 4 = present.

Parietal foramen (No. 6): (*Hauser and De Stefano 1989.78-82, Pl. XII*). Also known as *foramen parietale, emisarium parietale; foramina parietalia permagna*. One or two, rarely more foramina pierce the parietal near or in the sagittal suture in the obelion area. They vary in position, size and number. In 1/3rd to 1/6th of the population they are absent. Embryologically, the lateral angles of the bilateral clefts of the *fontanella obelia* may be perforated by vessels and so give rise to foramina when the ossification is complete (*Gisel 1964*). Large foramina known as foramina permagna are thought to represent a defective ossification of the parietal bones (*Pamperl 1919 quoted in Hauser and De Stefano 1989.81*) and are subsequently noted as a separate trait. In the present series none of the foramina permagna were recorded. The heritability estimate for absence of foramina parietalia is estimated to be high by Sjøvold (*1984*) in an extensive pedigree study. Berry and Berry (*1967*) scored presence only. Following Hauser and De Stefano (*1989*) and Buikstra and Ubelaker (*1994*), both presence and the position were scored. Since both sides were examined for presence, if the position is sutural, the score 2 was given for both sides to facilitate comparisons. Size has not been recorded. An extensive literature on sex differences (*see Hauser and De Stefano 1989 and quoted literature*) shows that there are no significant differences in the frequencies for males and females. Slight increase is observed up to 3 years. Ossenberg (*1969*) and Cesnys (*1985*) reported some increase from childhood to adolescence, while the trait seems to be stable throughout adulthood. Scoring procedures: values: *0* - absent; *1* - present, on parietal; *2* - present, sutural; *9* - unobservable. In the final analysis 0 = absent, 1 and 2 = present.

Sutural and fontanelle ossicles - Sutural bones: Surnumerary bones are present in a number of sutures of the skull. According to Sjøvold (*1984*) the heritability of these traits is very moderate. None of the surnumerary ossicles have a known or suspected medical relevance. Although a great degree of intercorrelation was reported for these surnumerary bones (*Hertzog 1968*) they are considered as reliable by Buikstra and Ubelaker (*1994*). Lambdoid ossicle and apical bone did not show any intercorrelation in the present study and were accordingly retained in the final analyses.

Lambdoid ossicle (No. 8) (Fig. 17) - One or more surnumerary bones can be situated within the lambdoid suture. Sex differences are not consistent as certain authors have found a significantly higher incidences in males (*Ossenberg 1969; Berry 1975; Perizonius 1979a; Molto 1983*) while Czarnetzki (*1975*) noted a tendency for more frequent occurrence in females (*Hauser and De Stefano 1989.93*). No sex correlation was found within the studied sample.

Fig. 17. Lambdoid ossicles a, band c. Lepenski Vir 48.

Apical bone (No. 23) - Also known as ossicle at lambda this surnumerary bone is located at lambda, within the posterior fontanelle. Hauser and De Stefano (*1989.88, Fig. 15a-d*) propose that not only presence or absence but also size and number be recorded. Also degree of protrusion into either parietal or occipital bone can be noted. In the present study no multiple bones were noted and only presence or absence were recorded. No sex predominance was recorded for this trait as well as no changes with age or artificial deformation of the skulls.

Auditory exostosis (No. 10) (Fig. 18): (*Hauser and De Stefano 1989.186-189, Pl. XXVIIa-c*). Also known as auditory torus, *torus auditivus*, *aural exostosis*, ear exostosis, auditory exostosis, exostosis of the external auditory meatus, *torus accusticus*, and *torus tympanicus* - a bony growth situated within or protruding from the external auditory meatus, essentially evolving from the tympanic part or occasionally also from squamous portion. Two different types of bony hyperostosis can be distinguished: the superficial hyperostosis in the outer type of the meatus, which is strictly speaking a pathological benign tumour with genetic predisposition; and the deep hyperostosis that has no genetic predisposition but is caused by prolonged irritation in cold water (*Kennedy 1986*). However, the distinction between superficial and deep meatal type is very difficult, and the present study follows the recommendation included in Buikstra and Ubelaker (*1994*), that is essentially the same as the three degrees of expression recommended by Hauser and De Stefano (*1989.187*). The reports on both sex and side dependence vary and frequencies vary from 0.0% in prehistoric Siberians (*Konzitsev 1972*), Canadian Inuit (*Dodo and Ishida 1987*), and modern Caucasoid North Americans (*Corruccini 1974a*), to 26.2% in medieval Serbian population (*Živanović 1979a*). An important article on auditory exostosis in the Vlasac material was published by Frayer (*1988*) who ascribes this trait to hand netting as a method of fishing the large cat-fish reported among the faunal material at the site (*Bökönyi 1978*). Although Zoffmann (*1983*) has reported lack of auditory exostoses in Lepenski Vir, 3/28 individuals (10.7%) were recorded on that site. While Frayer reported 13/38 individuals (34.2%), 17/46 (36.9%) were found in the present study. This could be due to the fact that Frayer has been able to examine only whole skulls from the site and not the fragmented material found mixed with the postcrania. But the incidence found in the current study does not differ significantly from his findings. At the site of Padina for which Živanović (*1975*) has stated that the auditory exostoses "are always present and very large" the incidence is even greater where 10/19 individuals had this trait (52.6%), while at Hajdučka Vodenica only 3/13 individuals had the trait (23%). Frayer's conclusion that the auditory exostoses can be related to the evidence for fishing, needs to be examined in more detail, since evidence for large fish in Lepenski Vir I is comparable to that of Vlasac, and no simple equation can be drawn between the two. However, there is a strong possibility that the majority of the occurrences of the tori are related to pathological rather than genetic condition and this concern has to be taken into account in the final analysis. Scoring was done as follows: values: *0* - absent; *1* - < 1/3 canal occluded; *2* - 1/3-2/3 canal occluded; *3* - > 2/3 canal occluded; *9* - unobservable.

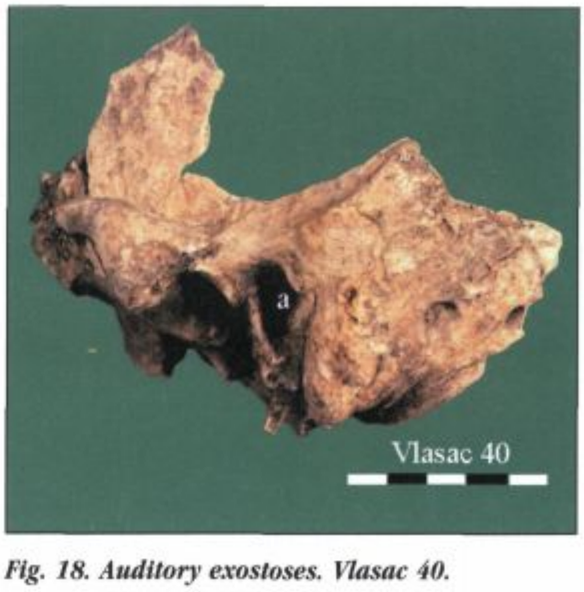


Fig. 18. Auditory exostoses. Vlasac 40.

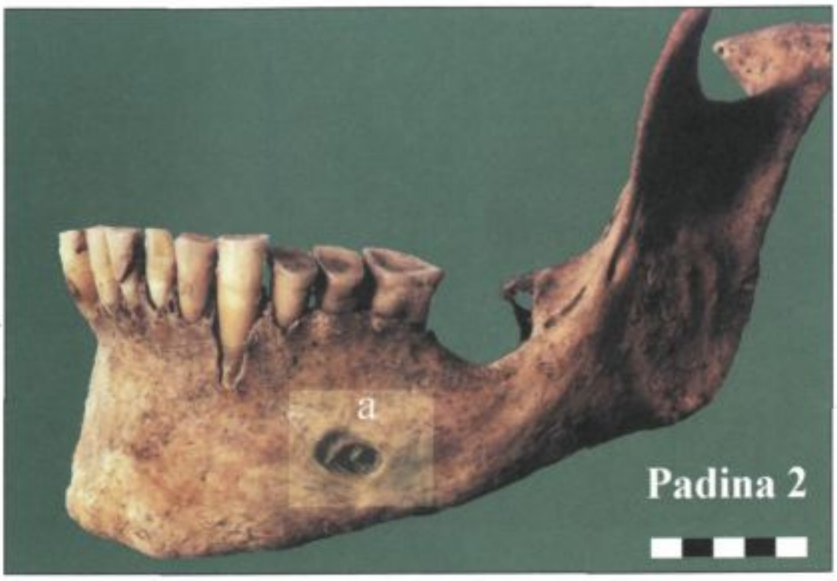


Fig. 19. Mental foramen. Padina 2.

Mental foramen (No. 11) (Fig. 19): *foramen mentale* (*Hauser and De Stefano 1989.230–3, Plate XXXIIIe–h*). A foramen situated on the exomandibular surface on each side of the mandible, generally in the area below the premolars and most often below the apex of the second premolar. The foramen may vary in shape and size, it may be double or multiple with varying distances between the apertures and in rare instances even absent. No genetic studies have been reported to date. Since the formation of the mental foramina happens before birth, there might be a fair amount of genetics involved. In the present study, only the number of foramina was recorded. In case of the inner division of the foramen (doubled foramen) it was recorded as 2 foramina. Reported frequencies of accessory foramina vary from 4.7 in modern Indians (*Gerhenson et al. 1986*) to 38.8 in Modern Blacks from Brazil (*Wijsman and Neves 1986*). There is no consensus on predominance acceding to sex, as it varies from one population to another. It occurs asymmetrically more often but there is no general preference of the side. Scoring procedures: values: *0* - absent; *1* - 1 foramen; *2* - 2 foramina or 1 foramen with complete inner division; *3* - more than 2 foramina; *9* - unobservable.

In the final analysis, since there were no instances of absence of foramina, the trait was treated as present only if 2 or more foramina or an inner division were present. If there was only one foramen, the trait was treated as absent.

Maxillary torus (No. 12) (Fig. 20): *torus maxillaris* (*Hauser and De Stefano 1989.180–3, Tab. XXVII d–g*). Also known as maxillary hyperostosis, *torus alveolaris maxillaris.* Both the irregular bony nodules of varying size and a mound like thickening of the lingual margin of the alveolar process in the molar area of the maxilla is referred to as maxillary torus. These protrusions may also involve the buccal side of the molars resulting in hypertrophy of the alveolar margin. In rare cases it can extend to PM4 or even a canine. There is a disagreement about its aetiology, and since it occurs more often in skulls with palatine torus, the same function and interaction between genetics and environmental factors can be proposed. The published results on incidence by sex are inconclusive (*Hauser and de Stefano 1989.183*) and need to be checked against each population. No sex correlation was found in this series. There seems to be no preference for side expression and either no change with age (*De Villiers 1968*) or a slight increase between young

Fig. 20. Maxillary torus. Vlasac 78a.

and old adults (*Van den Broek 1945*). The frequencies reported for different populations vary from 0.0% in recent Dutch (*Perizonius 1979*) and Italians from Sardinia (*Cossedu et al. 1979*) to 52.9% in western Australians (*Milne et al. 1983*). No intercorrelation with the palatine torus was found in the Iron Gates Gorge material. Scoring procedures: values: *0* - absent; *1* - trace (can palpate but not see); *2* - moderate: elevation 2mm - 5 mm; *3* - marked: elevation > 5mm; *9* - unobservable. In the final analysis, 0 = absent, and 1, 2 and 3 = present. Sufficient replicability was obtained both between observers and in intraobserver test to warrant inclusion of trace presence.

Palatine torus (No. 26): *torus palatinus* (*Hauser and De Stefano 1989.174–180, Tab. XXVI*). Also known as torus palatinus sagittalis, exostosis mediopalatina. The trait consists of paramedian, rarely median, bony protuberance of varying size, form and extent situated along the median suture of the hard palate. It may extend from the incisive foramen to the posterior border of the palatine bones. It may be short and restricted to a part of the hard palate. It is mostly situated in the middle, less commonly occupying the posterior, and very rarely in the anterior position. It varies also in the degree of expression and can be found either on both sides or only unilaterally (on either side of the median suture). Only the degree of expression was noted in the present study following Buikstra and Ubelaker (*1994*). Although various authors observed familial occurrence, and high concordance in monozygotic twins, others favoured functional explanation. The latter observation is based on the reduced frequencies in edentulous group and after the third decade observed by some authors. Hauser and De Stefano (*1989*) favour Schreiner's (*1935*) suggestion that a genetically determined strong osseous response to irritation leads to the formation of a palatine torus. The occurrence of palatine torus is already observed by a later foetal stage and in newborns. There is a marked age dependency in late infancy and during the first three decades of life both incidence and size continue to increase. Although Hauser and De Stefano (*1989.178–9*) report higher incidence in females than males in most of the series, there is too much variability to build a straightforward picture. No sex dependence was observed in the present study. Generally, the torus is rarely expressed before five years of age, there is a steady increase with age until the 3rd decade and subsequently a decrease which has been attributed to loss of teeth by Axelsson and Hadegaard (*1985*).

There is a disagreement on the correlation of the palatine, maxillary and mandibular tori, and these features have to be compared within the series itself. As noted for the maxillary torus, no intercorrelation between the two traits was observed. Scoring procedures: values: *0* - absent; *1* - trace (can palpate but not see); *2* - moderate: elevation 2mm - 5 mm; *3* - marked: elevation > 5mm; *4* - excessive covers most of the palate; *9* - unobservable. As in the case of maxillary torus, only 0 was recorded as absent, 1, 2, 3 and 4 were recorded as present.

Mylohyoid bridge (No. 13) (Fig. 21): *ponticulus mylohyoideus* (*Hauser and De Stefano 1989.234–237, Pl. XXXII*). Also known as canalis mylohyoideus, arcus mylohyoideus, mylohyoid bridging. The mylohyoid groove descends downward and anteriorly from the mandibular foramen endomandibularily. This groove can be covered by an osseous roof of varying length, and is thus transformed into a canal. The formation of this canal can begin at the upper or central part of the groove or more rarely both. The two can exist with an intermediate uncovered part. Although there have been no studies on the heritability of the trait, the pattern of regional and group variability suggests strong genetic basis. It is usually scored according to its location and degree. There are no conclusive results on the influence of sex and side symmetry and no correlations with either were found in the present study. According to Ossenberg (*1969*) it rarely achieves expression before adolescence and shows rapid increase into adulthood, but remains relatively stable in adult years.

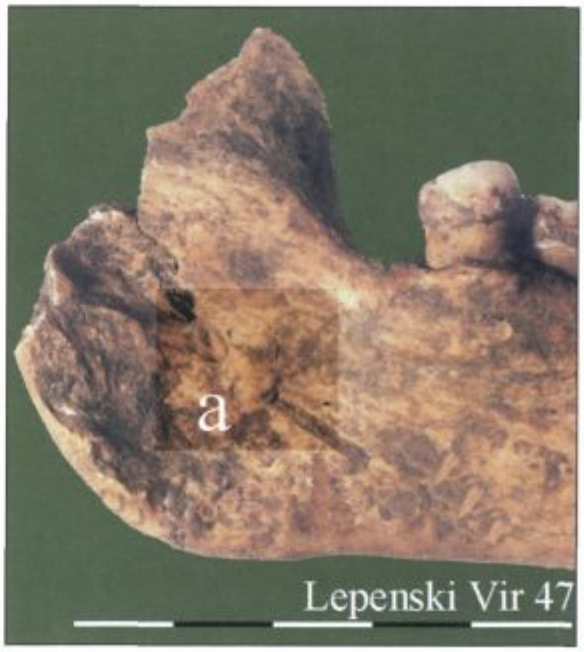


Fig. 21. Mylohyoid bridging. Lepenski Vir 47.

Frequencies between population vary from 5.8% in modern Japanese (*Mouri 1976*) to 33.7% in Aleuts (*Dodo and Ishida 1987*). Scoring procedures: values: *0* - absent; *1* - partial; *2* - complete; *9* - unobservable.

Septal aperture (No. 15) (Fig. 22): *Perforatio fossae ollecranii* (*After Sounders 1978*). The trait consists of any number of smaller or larger perforations between coronoid and olecranon fossae at the distal end of the humerus. Saunders (*1978.105-127*) notes both side and sex correlation for this trait. Both Finnegan (*1973*) and Gaherty (*1970*) have found important correlation with sex. However, no correlation with either side or sex was found in the present study. This is not uncommon, since studies differ in terms of results for correlations as has been shown in cranial traits. Apart from the possibility that correlations would occur randomly in the case of a great number of tests performed, and the possibility that the trait is simply spurious and lacking in biological significance (*Saunders 1978.121*), two other explanations are possible: (a) the trait's correlation with both side and sex differs among populations, and (b) that in order to get reliable results for trait correlation we need a greater sample size than in the current population. Although the results by Saunders are derived from much larger populations, the size of the population examined in this study was not negligible and the trait was subsequently retained. Scoring procedures: values: *0* - present; *1* - 1 small perforation with "thinning"; *2* - multiple small perforations; *3* - small perforation between 1-2 mm; *4* - perforation 2-5 mm; *5* - large perforation > 5 mm. In the final analysis 0 = absent; 1, 2, 3, 4 and 5 = present

Fig. 22. Septal aperture. Vlasac. Coding value "5".

Third trochanter (No. 17): *trochanter tertius* - A rounded, conical tubercle at the superior end of the gluteal tuberosity of the femur. The third trochanter appears as a separate trochanter-like entity, reasonably easy to distinguish, even from a very large gluteal tuberosity. According to Saunders (*1978.115, Tab. 5*) there is no side preference for this trait, and no correlation with sex in any of the separate samples studied. The trait was scored only as present or absent in the study. There is no inter-correlation for these two postcranial traits, nor are they correlated with any of the cranial traits in the present study.

4.2. Size and robusticity analyses

During a pilot study of the material in 1996, significant difference in size and robusticity between certain individuals became evident (Fig. 23). This observation is not new, as size and robusticity data have been used by Nemeskeri (*1978*), Živanović (*1975*) Mikić (*1981a*), Zoffmann (*1983*), and Schwidetski and Mikić (*1988*) to argue for different processes. Arguments were based on the degree of gracilisation pertaining to the skull. This preference for the skull in previous reports was partly responsible for concentrating on postcranial remains in the present study. Another reason for this choice is that morphometric changes in skull often illustrate changes in skull shape and robusticity at the same time. Postcranial measurements are far simpler and although changes in shape (often expressed as indices) are common due to a number of possible causes, size changes are more readily visible than in the case of the skull.

The list of variables was selected to provide the most information on size and, to a degree, on robusticity (as reflected in different indices). For description of the measurements refer to Buikstra and Ubelaker (*1994*). These variables are:

for clavicle - CML (maximal length); CAD (anterior-posterior diameter at midshaft); and CSD (superior-inferior diameter at midshaft);

for humerus - HML (maximal length); HEB (epicondylar breadth); HVD (vertical diameter of the head); HMXD (maximum diameter at midshaft); HMND (minimum diameter at midshaft);

for radius - RML (maximum length); RAPD (anterior- posterior diameter at midhsaft); RMLD (medial-lateral diameter at midshaft);

Fig. 23. Comparison of these two clavicles shows the striking extent of sexual dimorphism in the Iron Gates Gorge series.

for ulna – UML (maximum length); UMC (minimum circumference);

for femur – FML (maximal length); FBL (bicondylar length); FEB (epiconylar breadth); FMDH (maximum head diameter); FAPSD (anterior-posterior subtrochanteric diameter); FMLSD (medial-lateral subtrochanteric diameter); FAPM (anterior-posterior midshaft diameter); FMLM (medial-lateral midhsaft diameter); FMC (midshaft circumference);

for tibia – TL (length); TPEB (maximum proximal epiphyseal breadth); TMDB (maximum distal epiphyseal breadth); TMDNF (maximum diameter at the nutrient foramen) TTDNF (transverse or medial-lateral diameter at nutrient foramen); TCNF (circumference at the nutrient foramen);

for calcaneus – CCML (maximal length); CCMB (maximal breadth).

While examining the output of descriptive statistics, many of the variables were found to have too few observations. Only variables with more than 60 observations (25% of the adult sample) were retained for the initial metric statistics. These are CAD (61), CSD (60), HEB(62), HMXD (78), HMND (79), RAPD (71), RMLD (71), FMDH (60), FASPD (94), FMLSD (94), FAPM (90), FMLM (89), FMC (84), TMDNF (64), TTDNF (63).

Ideally this analysis aimed at providing a different template on the basis of which to redefine our subgroups. For each of the four sites a subsample of robust and a subsample of gracile individuals would be obtained. Then, frequencies of non-metric traits would be calculated for each of the subsamples, and compared.

If the robust subsamples would cluster together and the gracile together, we would have a strong case for populational differences in robusticity, with the incoming population more gracile. If, on the other hand, they would cluster in a different pattern, the scenario of gracilisation as the result of changed subsistence and lifestyle would be proposed.

However, this requires that a number of well-chosen measurements, providing the best separation either through PCA or discriminant analysis would be present for most of our adult specimens. Unfortunately, this was not the case. While single measurements could never be found in common on more than 90 skeletons, a combination of any two measurements (regardless of the fact that they were or were not correlated) could not be found on more than 71 individuals. When the number of measurements was increased to three, the number of comparable individuals fell to 46. Obviously, although anthropologists never expect an ideal situation, dividing 46 individuals into males and females, and then into 4 distinct sites and further into two robusticity groups, made the goal set out in the beginning impossible. However, size/robusticity analyses were still performed in order to see whether any distinct changes in size could be recognised between chronological periods described earlier.

4.2.1. Sex determination and consideration of sexual dimorphism

It has already been noted that in previous studies of the material, sex determination was based on both pelvic characteristics and some of the skull features associated with greater robusticity in males than females (*Nemeskeri 1978*). This can potentially create a problem, as same or intecorrelated features would be used for both sexual and populational distinction within the series.

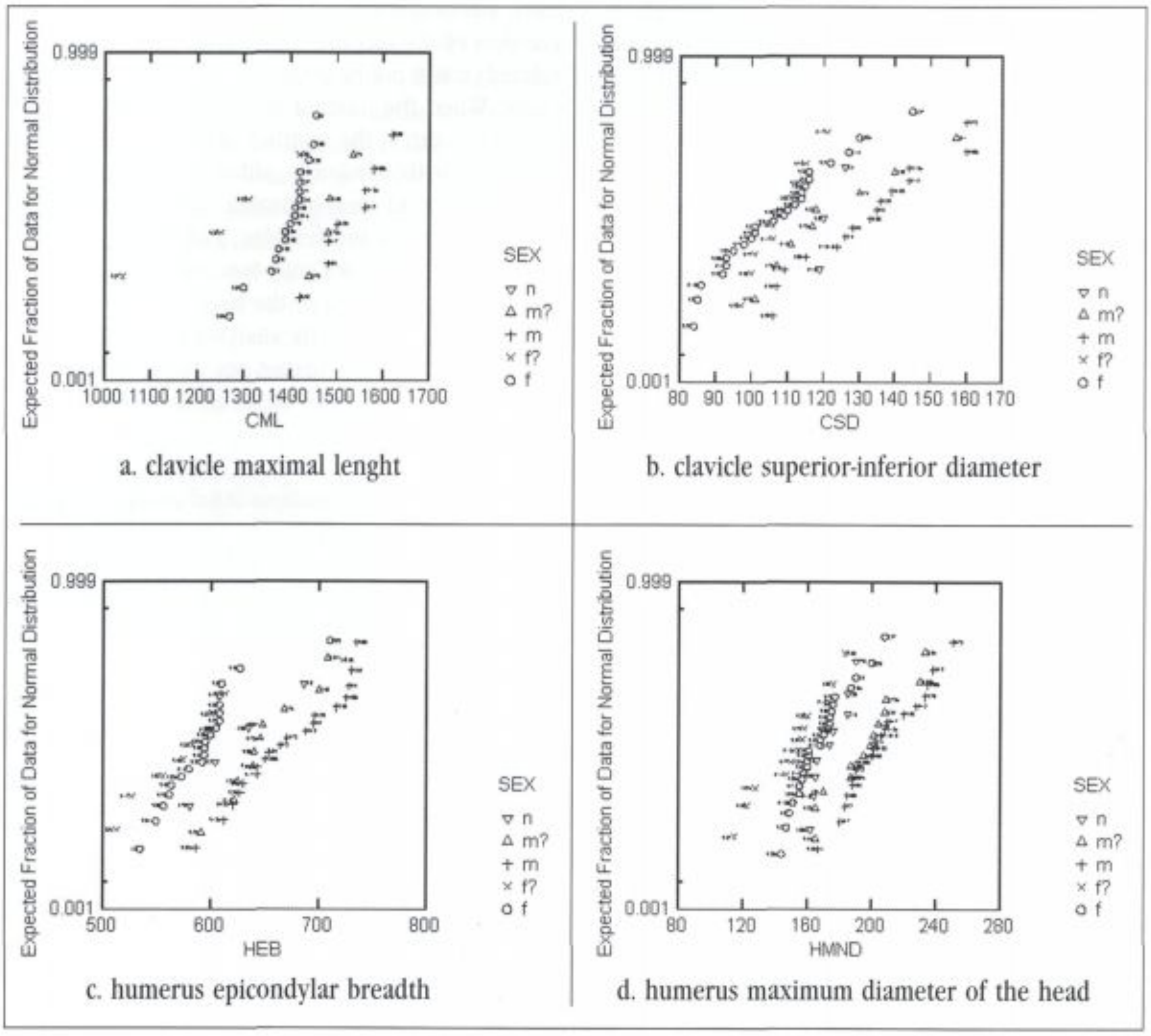
To avoid this methodological problem as well as ascertain to what degree we can determine sex based on size and robusticity data, only those individuals with pelvic remains sufficiently preserved to determine sex were assigned sex as males (m) or females (f). For all of the individuals where sex determination was based on any feature expressing secondary sexually characteristics (*Workshop of European Anthropologists 1980*), a question mark was added to the designation creating "m?" for males and "f?" for females. As presented in the above diagrams the two sexes clearly separate on the basis of simple size measurements presented as Probability Plots (Fig. 24 a–f). Probability plots were performed using SYSTAT 7 PPLOT command. They present a powerful visual display of the distribution of data. The values of the variable are plotted against the corresponding percentage points of a theoretical distribution (*Gnanadeskan 1977; Wilkinson 1990.345*). In this case the theoretical distribution is normal, and the data should, if normally distributed, lie on a straight line. The interesting feature of the presented plots is their extreme bimodality corresponding to sexes.

These probability plots show clear separation between males and females, and even more importantly they classify the "?" cases into their respective groups. Accordingly, the cases based on robusticity were considered as accurately determined in terms of sex to warrant their inclusion in the analysis. The "t" tests comparing sexes run on SYSTAT 7, showed significant difference for each variable examined.

Based on the above, the individuals assigned to m? and f? were added to their respective groups in order to get a more representative sample size. Further analyses were then based on thus assigned sexes. They are presented in the chapter 5.4. after the nonmetric analyses.

5. ANALYSIS AND RESULTS

This chapter provides the results of different statistical analyses performed on non-metric and metric data. The first three sections of the chapter (5.1. to 5.3) present discussion on the statistical treat-



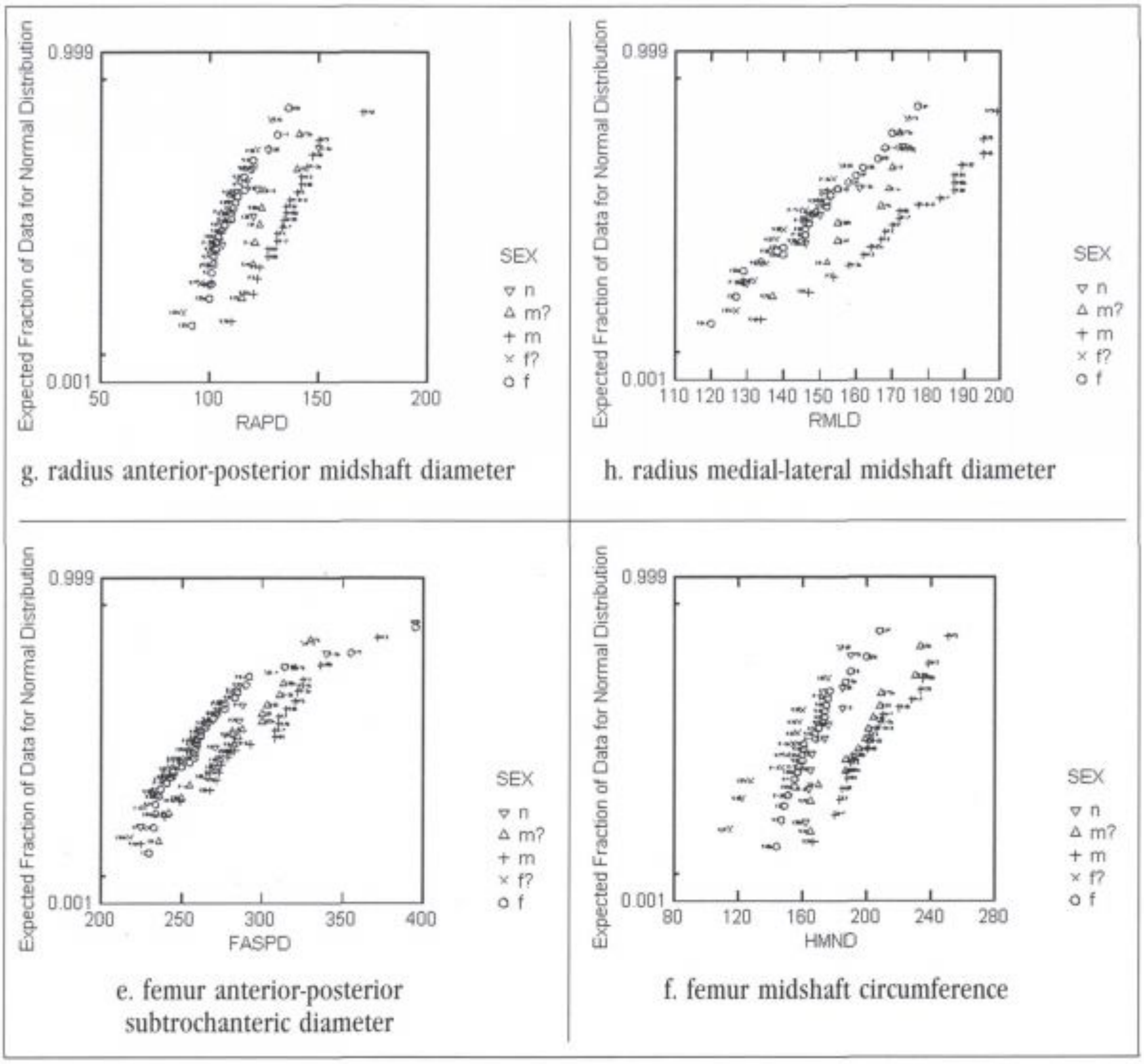
a. clavicle maximal lenght

b. clavicle superior-inferior diameter

c. humerus epicondylar breadth

d. humerus maximum diameter of the head

Fig. 24 a–d. Probability plots of different measurements. Overlaid diagrams for sexes. Note the linearity of the plots showing normal distribution, as well as the alignment of "?" individuals with their respective sex. "n" individuals remain unclassified.



g. radius anterior-posterior midshaft diameter

h. radius medial-lateral midshaft diameter

e. femur anterior-posterior subtrochanteric diameter

f. femur midshaft circumference

Fig. 24 e–h. Probability plots of different measurements. Overlaid diagrams for sexes. Note the linearity of the plots showing normal distribution, as well as the alignment of "?" individuals with their respective sex. "n" individuals remain unclassified.

ment of the non-metric data set. In Chapter 5.4. the results of analyses of the size/robusticity data are discussed.

Statistical analyses are crucial in examining large quantities of numeric data. They tend to become more complex in archaeological studies because of the problem of small sample sizes, representativeness and appropriateness of statistical methodology in studying archaeological data. Apart from samples being small and inadequate, they are often skewed with outliers and usually fraught with potential problems of archaeological context (*Key and Jantz 1990*).

Statistical analyses often rely on a number of assumptions that may or may not be valid for the archaeological samples. Two assumptions are made in this thesis:

① *The non-metric* traits have a strong genetic basis.
② *The sample* is representative of the populations we are trying to compare.

Let us consider the first assumption. Although the influence of changing environment (occupation, habitat, nutrition) cannot be excluded for most traits, this assumption is reasonably well founded in the research on the genetics of non-metric traits. We are examining the population structure and not the genetic make-up of the individuals, and therefore even if the influence of environment on the expression of traits (due to their threshold character) can not be disregarded, the validity of the population comparisons is not reduced.

The assumption of the representativeness of the sample that is examined can rarely be proved in the archaeological sample. As already discussed in Chapter 3, burial samples are often (if not always) biased. Even if we disregard the fact that excavations rarely expose the entire burial site, hoping that the excavation design has taken sufficient care to provide us with a representative picture, we have to keep in mind that buried individuals almost never reflect the living population. Since not everyone gets buried in a cemetery, and since the mode of deposition is strongly dependent on the social persona of the individual (*Masset 1993; Roksandić 2000 and quoted literature*), it is unreasonable to assume that the sample studied is unbiased. Furthermore, the direction of bias can be discerned only rarely, after a thorough study of all of the social, biological and taphonomic aspects of the skeleton.

Although we can not assume the representativeness of the sample for the purpose of studying the mortuary ritual and its social implications, there is hope that the populational biology (or the genetic makeup) of a changing population will still be represented adequately to discern it in our sample. Only under the circumstances of a completely different burial ritual for the local and the supposed incoming population, that would obliterate one or the other from our sample, the assumption of the representativeness could not be sustained. Although unlikely, this possibility had to be considered in the present study. Since burial ritual in the Mesolithic varies greately and becomes more or less canonised only in the Lepenski Vir IIIb period which belongs to the Middle Neolithic (*Antunović 1990*), and since inhumation is a demonstrated pattern for both of the periods, there is no reason to suspect total obliteration of any of the hypothetical groups in the current sample.

5.1. Statistical analysis of non-metric traits

Berry and Berry's (*1967*) article was a turning point in non-metric trait analysis for a number of reasons. It asserted the value of non-metric traits in population studies, it provided a lengthy list of cranial traits that were subsequently commonly used by many osteologists and, most importantly, it drew attention to the Smith-Grewal statistic for calculation of average distances between sample populations (*Saunders 1989.98*). Smith's Mean Measure of Divergence (MMD) has further been investigated and developed by Sjøvold (*1977*) and serves, with minor modifications, as the major statistic used for examining the inter-sample distance. Stated simply the Mean Measure of Divergence (MMD) is the summed divergence between two samples, divided by the number of traits included in the analysis.

For this type of analysis, proportions of the sample exhibiting a trait are given as *theta* (θ) values symmetrical around 0, such that the incidence of 50% equals a theta of zero (*Jackes et al. 1997.645*). Sjøvold has determined that the Anscombe formula is the best modification for calculation of θ, most accurately transforming the incidences of traits and stabilising the variance well, except in cases when incidences are extremely high or low (*Sjøvold 1977*). If the sample sizes are small and incidences are accordingly low, the Freeman-Tukey transformation is judged to provide somewhat better variance stabilisation than Anscombe (*Jackes et al. 1997.645*).

The actual formulae used in this study were taken from Jackes *et al.* (*1997*). The programming as well as the running of some of the data sets was done by Professor Mary Jackes on the QuatroPro spreadsheet program at the University of Alberta in Edmonton. Others were run by myself on MicrosoftExcel program provided by Professor Mary Jackes.

5.1.1. Formulae

The following formulae were used:

- Freeman Tukey transformation: appropriate for small sample sizes:

$$\text{theta}(\theta) = (0.5^*\arcsin(1-(2^*k)/(N+1))) + (0.5^*\arcsin((1-(2^*k+1))/N+1))),$$

where **k** is the number of skeletal elements showing the trait and **N** is the number of elements observed (where observations were possible).

- Anscombe transformation:

$$\text{theta}(\theta) = \arcsin[1-(2^*(k+0.375)/(N+0.75))]$$

- Mean measure of divergence: the summed divergence between two samples, divided by number of traits:

$$(\text{MMD}) = 1/r^*\Sigma[(\theta_1-\theta_2)^2 - V],$$

where **r** is the number of traits analyzed and

$$V = (1/N_1+0.5)) + (1/N_2+0.5)),$$

where **N** is the number of observations for each trait;

- the variance of the MMD $= \sigma^2 = 2/r^{2*}\Sigma(V^2)$

- The **Z** statistic (appropriate for any variable with normal distribution, mean of 0 and the variance of 1, which is the case of both theta and MMD) provides the significance for the MMD (*Jackes and Gao in press*):

$$Z = \sqrt{(2*S)} - \sqrt{((2*r) - 1)},$$

where

$$S = \Sigma[(\theta_1 - \theta_2)^2/V]$$

• Degree of isolation (DI) is calculated in order to confirm the **Z** value:

$$DI = MMD - (\sigma*2)$$

An MMD value that is more than twice its standard deviation is significant at .05: thus a positive **DI** value is significant. All of the tables provide the statistics calculated on the basis of these formulae. The **Z** statistic was used further to develop the dendrograms that show the relationships between different sites.

5.2. The organisation of the presentation of the analyses

Since many features in the chapter will be repeated from one analysis to the next, it is appropriate here to propose a number of explanations that will make the reading of different tables and figures easier.

Each analysis is presented through three tables and two figures that respect the same order and that are numbered with the table/figure number and the analysis number in brackets. The first number is a sequential number of the table or figure while the numbers in brackets refer to the analysis number and one of the following: (1) for the data table, (2) for the computer output table, (3) for the Z matrix table.

Table 22 therefore would indicate the Z matrix table of the second analysis. The same labelling is used for figures where numbers indicate: (1) dendrogram from cluster analysis, (2) multidimensional scaling plot.

Data tables – All of the data tables (see for example Table 11) presented in this section of the chapter follow the same outline. The shaded area on the left represents the trait number as given on Table 10 in the previous section. In the upper shaded row, the number refers to the site number, to which the name of the site is given in the following column (*e.g.* 1 for Hajdučka Vodenica, 2 for Lepenski Vir, 3 for Padina, and 4 for Vlasac). These numbers are important in understanding the Z matrix tables. "k" refers to the number of positive observations (trait present) while "N" refers to the total number of cases where the observation was possible (sum of trait absent and trait present).

Output tables (Tabs. 12, 13, 14, 15) – The first 4 columns on the left refer to the subsamples compared in the first two columns (names of sites, chronological units or combinations of the two that will be explained separately for each of the analysis) and numbers given to these subsamples in the next two columns (see for example Table 16). Following statistics are represented on all of the output tables (for formulas refer to section 5.2.1.):

mmdFT – mean measure of divergence;
sdFT – standard deviation;
standFT – standardisation value: mmd/sd. It is used when the sample sizes are different. This value is highly correlated with **Z** statistic. **Z** statistic is preferred by Jackes because it is more correlated with **di**;
total n – an average of the number of observations possible across traits for the units compared;
ZFT – provides the measure of significance for the **mmd**;
di – (**mmd** – **2*sd**) is strongly correlated with the **Z** and shows correlations as significant whenever this value is positive;
S – is used to calculate **Z** and is based on θ. The formula for this statistic is given in the section 5.2.1.

formula – **FT** stands for Freeman Tukey and signifies that the output is based on this transformation rather than Anscombe (which was also run).

These columns and values are consistently presented for each analysis. In analysing the distance between the populations, it is possible to use **MMD**, **Z** and **stand**. The choice here is based on the fact that **Z** is a way of standardising the minimal measure of divergence in case of unequal sample sizes and is more explicitly correlated with both MMD and DI, the latter being the measure of significance of the distance (*Jackes and Gao in press*).

'Z' matrix tables (see for example Tab. 12) – These are regular distance matrices. Upper and left shaded rows present the units of analysis either as numeric and textual (upper row) or only numeric (left row). The numbers are derived directly from the output.

Figures – Two figures are provided for each analysis: a Dendrogram derived from cluster analysis, and a Multidimensional Scaling (MDS) plot. Although it can be argued that MDS plots are a more appropriate way of presenting distance relationships (*Nance pers. comm.*), dendrograms are retained as they are commonly provided for these types of analyses in the literature and since some of the relationships are more readily visualised through them. The MDS plots definitely outline the relationships between all components in a more appropriate way so that most of the discussions are based on them. Labelling followed the pattern for tables.

Dendrograms (see for example Fig. 26) - Dissimilarity matrices were used to produce dendrograms on SYSTAT 7.0. The Linkage method is Complete as the most appropriate linkage for dissimilarity and similarity matrices. For comparisons of performance of different linkage methods see Wilmink and Uytterschaut (*1984*). The Complete linkage calculates the distance from every distance in the sample and thus avoids the pooling of the cases towards either the largest or the smallest distance provided. The distance measure used with the method is Euclidean, the SYSTAT default. Dendrograms are labeled as Figures with two serial numbers in brackets. The first number refers to the number of the analysis and the second number is always 1 (for dendrogram).

Multidimensional Scaling (see for example Fig. 27) - Since dendrograms can link the samples only in one direction, a spatial distance between different samples can be better appreciated by the information provided by the multidimensional scaling. To produce MDS plots, the same distance matrices as for dendrograms were used. Scaling is Monotonic, Kruskal Stress (measuring how well the curve fits all the points), and two dimensions because of the small number of points plotted were found the most appropriate. In each of the MDS plot figures, captions include the scores for the two dimensions, the Kruskal stress of final configuration - that should be less than .1 on a "good fit" (*Wilkinson et al. 1996.667*) - and a proportion of variance expressed, is presented.

5.2.1. The discussion of sides

Since no side correlations were found for any of the traits used in the analyses (Tab. 10), several approaches were possible:

Method 1 - to select only one side per individual and use the record for that side only (*favoured by Saunders 1978*)

Method 2a - to pool sides for each individual. The incidence is calculated as the number of individuals with trait present on one or both sides/number of individuals. Proponents of the first approach argue that it is more reasonable to treat individuals rather than sides as members of the breeding unit. Further, because of the age dependency of the proportion of bilateral occurrence, the side method exaggerates the effect of age-regression in variant incidence, the side method artificially inflates sample size and introduces redundant information deriving from strong positive left-right correlation in trait presence (*Molto 1983.133*). The individual approach is favoured by Buikstra (*1972*) and Suchey (*1975*). The rationale behind the 'individual' method is that, since nonmetric traits are threshold characters, any expression of a trait should be treated as 'trait present' and therefore, if a trait is expressed on either of the sides, it is regarded as present. This leaves us with a number of cases in which not both of the sides are sufficiently preserved to warrant determination. These cases could be included only when present, while, when absent, they would be excluded from the analyses since we can not ascertain whether they were expressed on the other side. This would drastically reduce the number of observations (already low at some sites and periods) and would accordingly - because of the small sample sizes, substantially bias the frequencies, which in turn would make comparisons with any other material impossible.

Method 2b - pooling sides by randomly selecting one or the other in case their expressions differ. Because the discussed 'individual' method was not operational as it selects against poorly preserved skeletons with trait absent, an attempt to overcome this problem was made by selecting the sides (in cases where the expression differs) randomly. In this way it was possible to retain 'individuals' as units of observation, while avoiding the problem of increasing incidence in a sample of small size due to unequal representation of sides.

Method 3 - adding sides and treating the material by elements and not by individuals. In this case the incidence is calculated as number of skeletal elements (regardless of the side) with traits present/ total number of elements. This method is preferred by Ossenberg (*1978 quoted in Molto 1983.136-137*) who proposed the theoretical explanation as to why 'side' method should be more successful than 'individual' method. She argues that the observed correlation between the intensity of trait incidence and the proportion of bilateral expression reflects genetic factors since an individual expressing a trait bilaterally has a stronger dose of trait positive alleles than an individual with unilateral expression of the trait. Therefore, computing the frequency of a discrete trait on the basis of pooled sides quantifies the genetic potential in the population better than does the individual count. This way of recording has the benefit of expressing the underlying threshold character of the traits as it takes into account the total genetic potential for the trait expression within population. It also increases the sample sizes in many cases without violating the biological bases of the trait expression. Accordingly, sides were added in the following manner:

$$k/N\ L + k/N\ R = k/N$$
or
$$(2/5 + 3/8 = 5/13)$$

where k is the number of instances in which the trait was recorded as present, while N is the total number of possible observations.

In order to demonstrate how similar these two methods are in their outcome, a series of analyses were performed using 'individual' (with sides pooled by 2b method) and 'side' method where skeletal elements are treated as discrete units. Here only one of the two pairs is presented as illustration. Since they differ very little in the significance of the results and resulting distance measures, side method was used as it allowed for increased sample size.

5.2.2. Analyses based on the individuals (method 2b) for sites (Tab. 11)

In this analysis only 10 traits which had sample sizes of 5 or more were used. Although sample size of five is far from desirable, insisting on more representative sample sizes would have made comparisons with Hajdučka Vodenica impossible for most of the traits.

trait	1	HVod	2	LVir	3	Padina	4	Vlasac
no.	k	N	k	N	k	N	k	N
2	2	5	8	26	8	16	4	37
3	5	9	14	28	13	16	24	49
6	5	6	16	31	12	16	26	42
10	3	13	3	28	10	19	17	46
11	1	15	0	35	2	19	4	47
12	1	6	3	25	1	8	8	31
13	1	9	7	11	2	14	9	17
15	1	5	5	15	3	11	19	47
17	0	8	7	18	3	8	9	26
25	1	5	9	28	2	12	16	45

Tab. 11. "k" and "N" values for sites based on individuals.

5.2.3. Analyses based on the elements (method 3) for sites (Tab. 13)

As can be seen from the above figure, the multidimensional scaling produces the same spatial relationships between the four sites regardless of the method of pooling the side information. The differences in the positioning of Vlasac and Lepenski Vir on the diagram (Fig. 25) result from the difference in the "Z" statistic (Tabs. 12 and 14), that has increased twice because of the greater sample size. The actual relationship between the sites has remained the same. Accordingly, only the analyses performed by element are presented in further discussions.

Z(ft)	1	2	3	4
1	0			
2	1.5643	0		
3	−0.0926	3.2085	0	
4	1.1091	1.5259	2.4937	0

Tab. 12. Z matrix based on individuals.

trait	1	HVod	2	LVir	3	Padina	4	Vlasac
no.	k	N	k	N	k	N	k	N
2	4	9	14	46	13	24	4	62
3	8	14	24	50	22	27	41	82
6	7	10	31	60	23	28	44	77
10	7	22	5	48	17	33	27	76
11	1	21	2	61	3	30	6	82
12	1	9	6	41	1	13	15	59
13	2	14	12	18	4	25	16	32
17	0	10	12	29	4	13	13	35

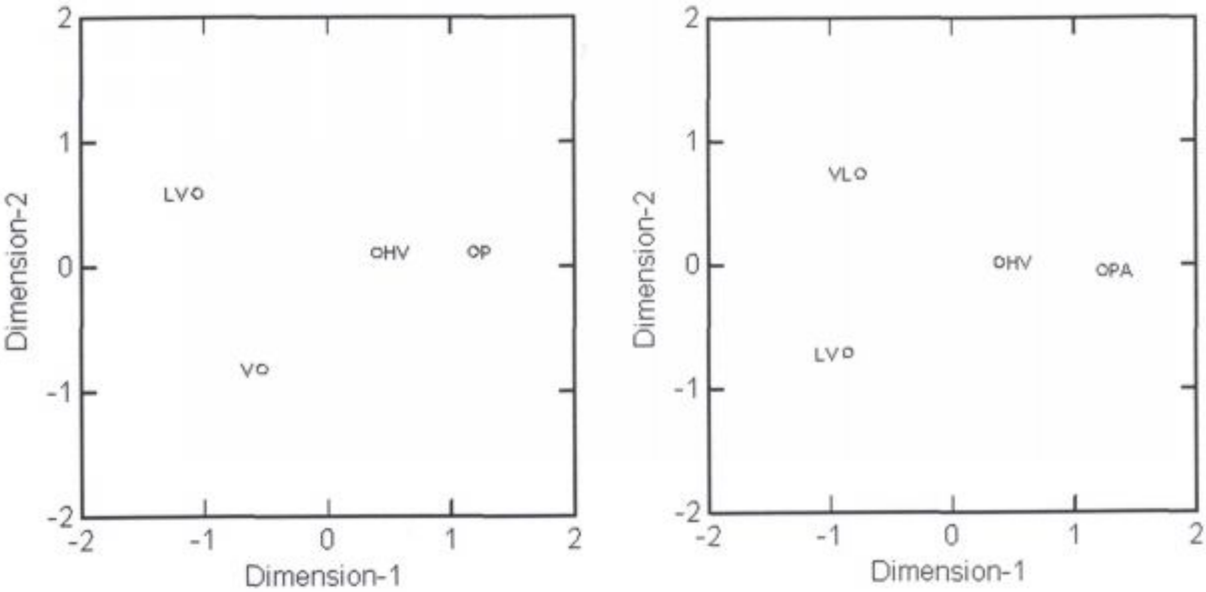
Tab. 13. "k" and "N" values for sites based on elements.

Z(ft)	1	2	3	4
1	0			
2	3.1996	0		
3	0.7411	6.1667	0	
4	2.8046	3.3144	5.9511	0

Tab. 14. Resulting "Z" matrix based on elements.

5.3. Results of the analyses of non-metric traits

In subsequent analyses, the Iron Gates Gorge population was divided into subsamples based on sites, chronology, and combination of sites and chronology. According to the discussion of the meaning of Mesolithic and Neolithic in the context of the region, the chronological division comprises three periods: Mesolithic, Mesolithic/Neolithic, and Neolithic. Mesolithic presumes lack of contact with farming populations, Mesolithic/Neolithic, the period when the contact, even if it did not take place, was possible, and the Neolithic, when the change in the subsistence base is evidenced on one of the sites.



a) based on sides polled by individuals (method 2b)

b) based on added sides (method 3)

Fig. 25. Multidimensional scaling for the two different methods of pooling sides.

In order to assess the degree of difference and meaning of the relationships within the group, an outlier was chosen from the published literature. The chosen outlier is Franzhausen I, a Bronze Age population from Austria (*Wiltschke-Schrotta 1992*), based on a number of variables that were recorded in common, the system of recording that followed the same general procedures (*Czarnetzki 1972a; 1972b; 1972c; Czarnetzki et al. 1985; Buikstra and Ubelaker 1994; Hauser and De Stefano 1989*). Also, the site is sufficiently removed chrono-spatially, but still within the same general geographic area, to be appropriate as an outlier. Importantly, Wiltschke-Schrotta has recorded her sides separately and has presented the side data in a manner that made it possible to add them up without problems and obtain a methodologically comparable sample.

5.3.1. Analysis based on Sites (Tabs. 13, 15 and 16)

The first set of analyses investigate if any particular patterns of difference are observable between geographic units (sites) and assesses whether there was any genetic separation between Lower and Upper Gorge. Traits that had at least 9 observation at any of the sites were used (Tab. 13).

As suggested by the dendrogram (Fig. 26), Hajdučka Vodenica and Padina are virtually identical. The dendrogram also shows that Padina is further removed from both Lepenski Vir and Vlasac. However, it fails to show that Hajdučka Vodenica is not as removed from the two sites as is Padina with which it clusters.

The interpretative potential of the diagram in Figure 27 is very limited. Hajdučka Vodenica (Lower Gorge) and Padina (Upper Gorge) seem to be virtually identical, although they are the most geographically removed. Other differences are significant and most pronounced between Padina and Vlasac and Padina and Lepenski Vir. Since both Hajdučka Vodenica and Padina have a significant Mesolithic/Neolithic component, while Vlasac has important Mesolithic as well

site1	site2			mmdFT	sdFT	standft	total n	ZFT	diFT	SFT	formula
HVod	Lvir	1	2	0.2513	0.0540	4.6572	58	3.1996	0.1434	25.0106	ft
HVod	Padina	1	3	0.0495	0.0647	0.7656	38	0.7411	–.0798	10.6451	ft
HVod	Vlasac	1	4	0.2264	0.0499	4.5344	77	2.8046	0.1266	22.2953	ft
LVir	Padina	2	3	0.3246	0.0374	8.6891	68	6.1667	0.2499	50.3980	ft
LVir	Vlasac	2	4	0.0792	0.0237	3.3428	107	3.3144	0.0318	25.8292	ft
Vlasac	Padina	4	3	0.2800	0.0332	8.4249	87	5.9511	0.2135	48.2567	ft

Tab. 15. The output of the statistical analysis of sites.

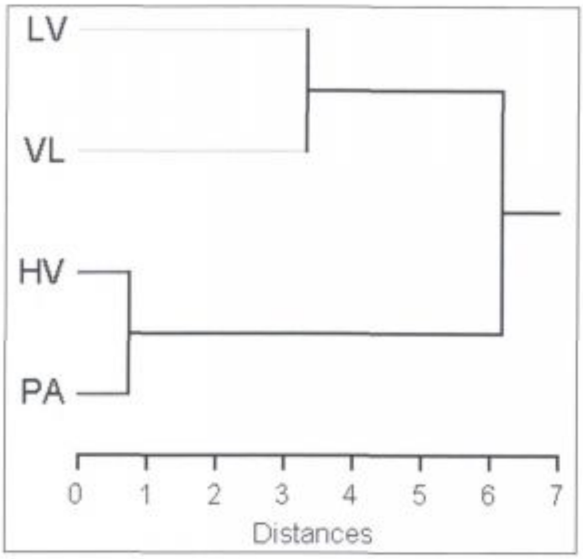


Fig. 26. Dendrogram based on dissimilarity matrix, Euclidean distance and complete linkage showing relationship between different sites examined.

Z(FT)	1 Haj. Vodenica	2 Lep. Vir	3 Padina	4 Vlasac
1	0			
2	**3.1996**	0		
3	0.7441	**6.1667**	0	
4	**2.8046**	**3.3144**	**5.9511**	0

Tab. 16. Matrix of Z values for sites. Significant relationships are outlined in bold.

as Mesolithic/Neolithic component and all three periods are represented at Lepenski Vir, it is impossible to argue for isolation based on geography at least in the Mesolithic/Neolithic period.

5.3.1a. Subsamples based on sites with Franzhausen I (Tabs. 17, 18 and 19)

In order to evaluate the distance between different sites, an outlier is introduced into the analysis. This outlier is Franzhausen I site dated to the Bronze Age in Austria. The choice of this outlier was guided by a number of concerns and has already been discussed.

A quick look at Table 20 shows only the difference between Hajdučka Vodenica and Padina to be non-significant. All other distances are significant.

Again, Hajdučka Vodenica and Padina remain virtually identical (Fig. 28), while all other

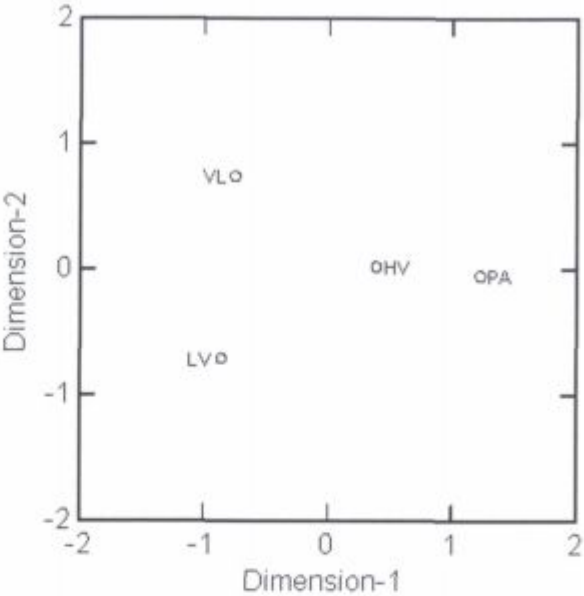


Fig. 27. Diagram showing output of the Multidimensional Scaling for sites, based on dissimilarity matrix. Dimensions (1, 2): HV (.38, .02); LV (-.86, -.71); PA (1.22, -.05); VL (-.75, .74). Kruskal Stress of final configuration: 0. Proportion of variance: 1.00.

sites seem to be significantly different from each other. Franzhausen, as expected, is the most removed from other sites, while Padina and Lepenski Vir and Padina and Vlasac show next most significant difference. Of all the sites, Hajdučka Vodenica seems to be just slightly closer to Lepenski Vir and Vlasac than to Franzhausen. Padina seems to be almost equidistant from both Lepenski Vir and Vlasac, Lepenski Vir is at the same distance from Vlasac as from Hajdučka Vodenica.

The Multidimensional scaling plot (Fig. 29) shows clear grouping of the Iron Gates Gorge sites against the more removed Franzhausen I site. It also shows that in one dimension Padina and in another Lepenski Vir seem to be the most removed from an imag-

Trait no.	1 k	HV N	2 k	LVir N	3 k	Padina N	4 k	Vlasac N	5 k	FRI N
2	4	9	14	46	13	26	4	62	8	588
6	7	10	31	60	23	28	44	77	211	425
10	7	22	5	48	17	33	27	76	130	638
11	1	21	2	60	3	40	6	82	46	530
12	1	9	6	41	1	10	15	59	8	365
13	2	14	12	18	4	25	16	32	28	446
17	0	10	12	29	4	13	13	35	116	318

Tab. 17. "k" and "N" values used in the analysis of sites with Franzhausen I.

site1	site2	site 1 name	site 2 name	mmd FT	sdFT	stand FT	total n	ZFT	di FT	SFT	formula
1	2	HVmn	LV	0.2954	0.0590	5.0063	57	3.4171	0.1774	24.6591	ft
1	3	HVmn	P	0.0233	0.0724	0.3214	39	0.2896	–0.1216	7.5861	ft
1	4	HVmn	V	0.2678	0.0547	4.8985	74	3.0388	0.1585	22.0737	ft
1	5	HVmn	FRI	0.3548	0.0460	7.7127	486	4.2742	0.2628	31.0451	ft
2	3	LV	P	0.2900	0.0429	6.7659	68	5.3277	0.2043	39.9015	ft
2	4	LV	V	0.0946	0.0263	3.5981	104	3.5686	0.0420	25.7342	ft
2	5	LV	FRI	0.4219	0.0169	24.9836	516	9.5513	0.3881	86.5518	ft
3	4	P	V	0.2290	0.0385	5.9491	85	4.9147	0.1520	36.2973	ft
3	5	P	FRI	0.3769	0.0299	12.5989	498	8.7299	0.3171	76.0812	ft
4	5	V	FRI	0.2554	0.0118	21.6578	533	8.9086	0.2319	78.3023	ft

Tab. 18. The output of the statistical analysis of sites with Franzhauesn I.

ined centre of the four. Noteworthy is that both of them have ceramics *in situ* with Lepenski Vir type house floors. They also have an important Mesolithic component with no evidence of contact. However, the general pattern is that of heterogeneity.

Z(ft) matrix	1 H.Vodenica	2 L.Vir	3 Padina	4 Vlasac	5 FRI
1	0				
2	**3.4171**	0			
3	0.2896	**5.3277**	0		
4	**3.0388**	**3.5686**	**4.9147**	0	
5	**4.2742**	**9.5513**	**8.7299**	**8.9086**	0

Tab. 19. Matrix of Z values for sites with Franzhausen I. Significant relationships are outlined in bold.

5.3.2. Subsamples based on chronology (Tabs. 20, 21 and 22)

Chronological units in these analyses are derived from the data presented in Chapter 3. The baseis for distinguishing the units is provided by the evidence of economic behaviour and evidence of contact with peoples with different economic patterns. Mesolithic refers to the strata within any of the sites where the economy is fully Mesolithic and there is no evidence of contact. The Mesolithic/ Neolithic (Meso/Neo, or M/N in tables and Cont. in diagrams) is the period when contact with

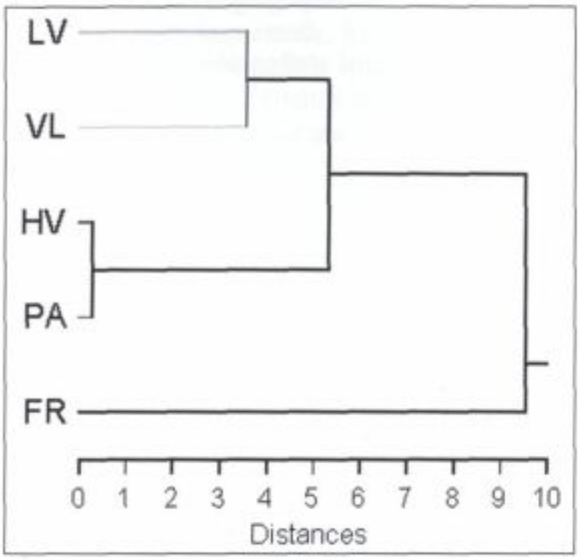


Fig. 28. Dendrogram showing relationship between the Iron Gate's Gorge sites and Franzhausen I. Based on dissimilarity matrix, Euclidean distance and Complete linkage.

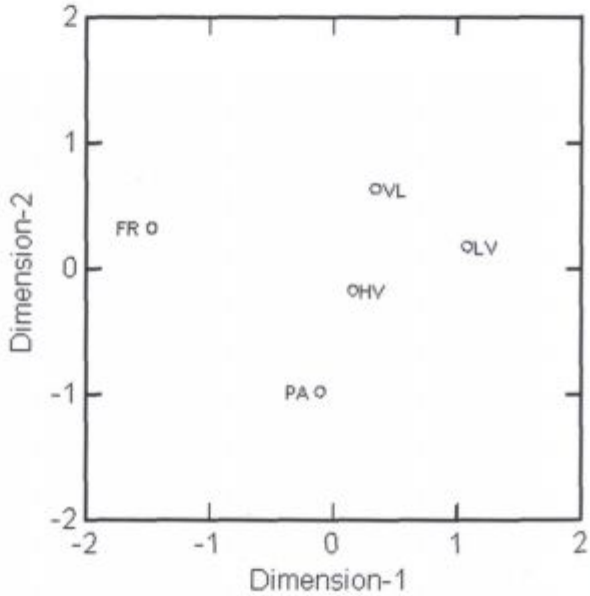


Fig. 29. Multidimensional scaling for the sites with Franzhausen I. Based on dissimilarity matrix. Dimensions (1, 2): HV (.16, –.14); LV (1.00, .39); PA (.12, –1.00); VL (.23, .69); FR (–1.51, .05); Kruskal Stress of final configuration: 0.0270. Proportion of variance: 0.9941.

Trait no.	Mesolithic k	1 N	Meso/Neo k	2 N	Neolithic k	3 N
1	30	33	20	45	1	8
2	10	55	16	66	8	14
3	40	60	43	77	6	14
4	9	66	14	65	2	12
5	23	42	29	43	4	9
6	42	67	48	76	8	18
7	0	62	4	70	0	18
8	16	62	23	73	5	16
10	30	50	26	85	0	15
11	6	81	4	82	1	18
12	12	46	7	51	2	13
23	8	33	3	32	0	10

Tab. 20. "k" and "N" values for traits used in the analysis of chronological units.

farming communities in the region becomes possible. This is similar to the porous frontier of Dennell (*1985*) or availability phase of Zvelebil (*1996a*). Neolithic is, primarily, characterised by greater importance of domesticates in the economic base (>5%). Evidence of adoption of cultural elements of the surrounding farmers of the Balkano-Anatolian and Balkano-Karpathian basin (*ENCB and MNCB of Tasić 1998*) although considered, was not taken as sufficient for determining the find as Neolithic.

A significant feature of the dendrogram (Fig. 30) is clustering of Mesolithic/Neolithic (Contact) period with Neolithic period, which is in contradiction with the wave of advance model for the neolithisation of this region.

site 1	site 2	Site 1 name	Site 2 name	mmd FT	sd FT	stand FT	total n	Z FT	di FT	S FT	formula
1	2	Meso	MN	0.1298	0.0155	8.3884	119	4.8968	0.0988	46.9740	ft
1	3	Meso	LVn	0.4667	0.0398	11.7260	69	6.4826	0.3871	63.6011	ft
2	3	MN	LVn	0.1017	0.0388	2.6230	78	2.4289	0.0242	26.0986	ft

Tab. 21. The output of the analysis of chronological units.

Z (ft)	1 Mesolithic	2 Meso/Neo	3 Neolithic
1	0		
2	**4.8968**	0	
3	**6.4826**	**2.4289**	0

Tab. 22. Matrix of Z values for chronological units. Significant relationships are outlined in bold.

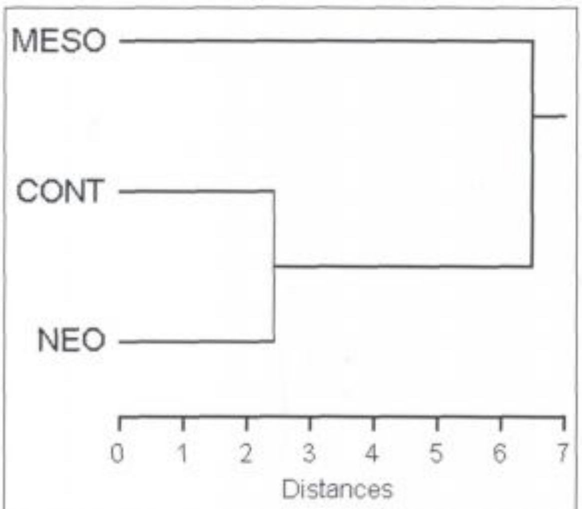


Fig. 30. Dendrogram showing internal relationship of chronological units. Derived from dissimilarity matrix, Euclidean distance, Complete linkage.

In order to demonstrate the spread of Neolithic farmers themselves, and not only their domesticates and/or knowledge, the result should show a slight to non-existent change in the Contact period (as some exchange of genes could be expected) and an abrupt change with the advent of Neolithic. This pattern would argue for an insurgence of people with different genetic make-up who brought about the change in economic base (*as proposed by Cavalli Sforza 1996*). It would also imply that the farmers are genetically different from the foragers in the region.

The outcome presented in the dendrogram (Fig. 30) shows that more change (regardless of its cause) happens between the Mesolithic and Contact period than Contact and Neolithic which cluster together. If indeed the new population moves in at the time of Mesolithic/Neolithic, it does not bring about an immediate change in the economic base and can not be understood in accordance with the "wave of advance" model.

All of the relationships are significant according to the "di" value (Tab. 21). It is noteworthy that the distance between Mesolithic and Contact is more than twice the distance between Contact and Neolithic. This is even more suggestively shown by the Multidimensional scaling plot (Fig. 31).

If there is, indeed, an exchange of genes as well as goods at the time of the first contact, it does not destabilise the Mesolithic society and ideology, as can be seen from the continuation of architectural elements, mobiliary art and general organisation of the sites. Even more importantly, as the basis of subsistence remains hunting, gathering and fishing, this supposed exchange of genes does not bring about a fully developed farming economy.

It is important to note that a certain amount of change in the genetic make-up, as evidenced in the non-metric traits, would be expected due to secular trends. However, for secular trends to be the only source of change, the distances between different periods would need to be approximately the same. The diagram in Figure 31 strongly suggests a change in the population structure at the time of Mesolithic/Neolithic period. There is an indication that, apart from the obvious secular trend reflected in the alignment of the units, a greater amount of change happens between Mesolithic and Contact periods. The introduction of an outlier in the next analysis is aimed to clarify how important this difference was in the amount of genetic change.

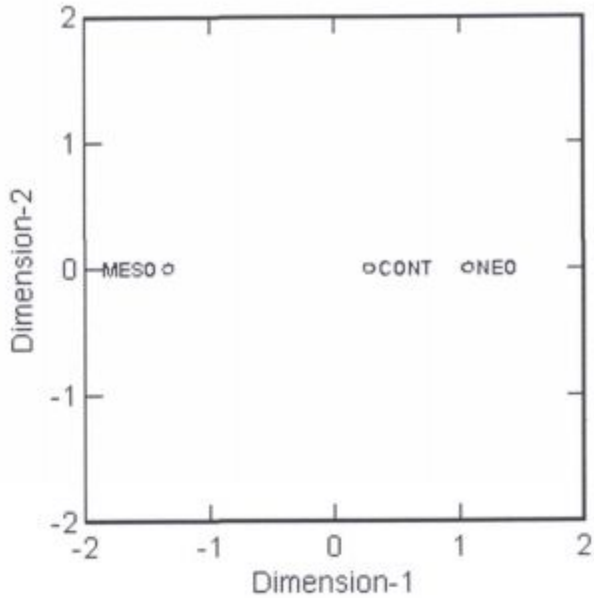


Fig. 31. Multidimensional scaling plot of chronological units based on dissimilarity matrix. Dimensions: (1, 2): Meso (-1.34, .00); Cont. (.27, .00); Neo. (1.07, .00); Kruskal Stress of final configuration: 0.00. Proportion of variance: 1.00.

5.3.2a. Subsamples based on chronology with Franzhausen I (Tabs. 23, 24 and 25)

With the introduction of Franzhausen, further removed in time and space from the subsamples in the studied region, a better appreciation of distance is possible.

As is evident from the Table 24, the difference between Contact and Neolithic periods ceases to be significant when an outlier is introduced (as shown by a negative 'di' value). Furthermore, distances between Mesolithic and Contact, and Contact and Neolithic, according to the Z statistic, become almost equal.

The ensuing dendrogram shows strong clustering of Mesolithic and Contact regardless of the fact that the "di" value determines this relationship as significantly different. Part of the responsibility might lay in the larger "sd" and smaller sample size. There is very little actual difference between Mesolithic, Contact and Neolithic an indication of continuity, with accumulated changes through time resulting in significant difference between Mesolithic and Neolithic.

The introduction of Franzhausen shows that the distances on the local scale become less obvious and that in general they follow the secular trend. However, the unidimensionality of dendrogram (Fig. 32) obscures some of the very important information, and a look at the Figure 33 explains the incompatibility of the clustering information to that provided by the "di" statistic.

While Contact period is almost equidistant from the Mesolithic and Neolithic periods, the two are diffe-

Trait no.	Meso k	1 N	M/N k	2 N	Neo k	3 N	Franz I k	4 N
2	10	55	16	66	8	14	8	588
5	23	42	29	43	4	9	90	451
6	42	67	48	76	8	18	211	425
8	16	62	23	73	5	16	27	190
10	30	50	26	85	0	15	130	638
11	6	81	4	82	1	18	46	530
12	12	46	7	51	2	13	8	365
13	16	39	15	42	1	5	28	446
23	8	33	3	32	0	10	16	194

Tab. 23. "k" and "N" values for traits used in the analysis of chronological units with Franzhausen I.

site 1	site 2			mmdFT	sd FT	stand FT	total n	Z FT	di FT	S FT	formula
1	2	Meso	MN	0.0411	0.0187	2.1905	114	2.0405	0.0036	18.9949	ft
1	3	Meso	N	0.3244	0.0530	6.1157	66	5.1131	0.2183	42.6539	ft
1	4	Meso	FrI	0.3561	0.0111	31.9687	478	12.7567	0.3339	142.4636	ft
2	3	MN	N	0.1024	0.0522	1.9597	74	2.4522	-0.0021	21.6171	ft
2	4	MN	FrI	0.2874	0.0103	27.8134	486	12.0167	0.2668	130.2460	ft
4	3	FrI	N	0.3327	0.0448	7.4201	438	5.8392	0.2430	49.6241	ft

Tab. 24. The output of the analysis of chronological units with Franzhausen I.

rently positioned in respect to Franzhausen (Bronze Age). Namely, the Contact, Neolithic and Franzhausen are to be found on the same axis, while the Mesolithic period forms a different pattern and is situated on a different axis with Contact period.

Z matrix	1 Mesolithic	2 Meso/Neo	3 Neolithic	4 Franz I
1	0.0000			
2	**2.0405**	0.0000		
3	**5.1131**	2.4522	0.0000	
4	**12.7567**	**12.0167**	**5.8392**	0.0000

Tab. 25. Matrix of Z values for chronological units with Franzhausen I. Significant relationships are outlined in bold.

While secular trend is a definite factor in the change from the Mesolithic to the Neolithic and Bronze Age, a significant change, that cannot be explained solely by temporal trend, occurs at the time when the contact with Neolithic populations becomes possible in the Iron Gates Gorge.

5.3.3. Subsamples based on combined chronology and sites (Tabs. 26, 27 and 28)

Subsamples that respected both sites and chronological determination were analysed in order to provide a more fine-grained understanding of the relationship among them. The Padina sample, when divided into Mesolithic and Mesolithic/Neolithic, made comparisons almost impossible because of the small numbers of observations in almost all variables. Since Padina clusters consistently with Hajdučka Vodenica, and since most of the individuals from Padina belonged to the same chronological unit (Mesolithic/Neolithic) those were assigned to Hajdučka Vodenica subsample and thus form the HVPmn (Hajdučka Vodenica-Padina Mesolithic Neolithic). The remaining

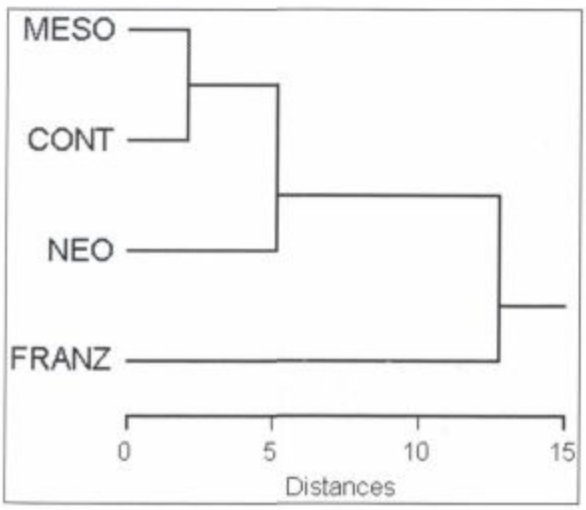


Fig. 32. Dendrogram showing the changing relationship with the introduction of Franzhausen I. Based on dissimilarity matrix, Euclidean distance and Complete linkage.

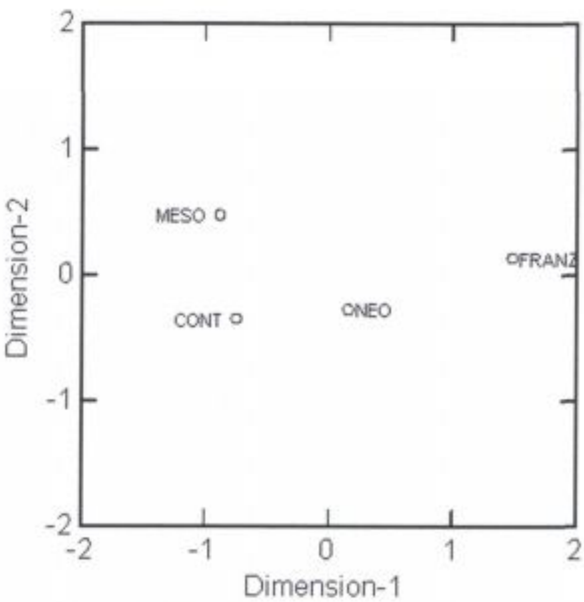


Fig. 33. Multidimensional scaling plots for Chronological units with Franzhausen I. Based on dissimilarity matrix. Dimensions (1, 2): Meso (–.88, .48); Cont. (–.75, –.35); Neo. (.15, –.27); Franz I (1.48, .14). Kruskal Stress of final configureation: 0.00. Proportion of variance: 1.00.

individuals from Padina that belong to the Mesolithic were assigned to Lepenski Vir Mesolithic subsample (forming LVPm – Lepenski Vir Padina Mesolithic). This was done in order to strengthen the Mesolithic sample of Lepenski Vir after a careful examination of frequencies. Although the frequencies do not show substantial differences, this should be kept in mind in the analyses and interpretation.

According to the distance matrix (Tab. 28) produced here, the most similar are Hajdučka Vodenica/Padina Contact group with Lepenski Vir Neolithic. This points to a strong continuity between the two periods. Along these lines is the similarity between Lepenski Vir Contact with the Lepenski Vir Neolithic. But Hajdučka Vodenica/Padina group also shows little difference from the Lepenski Vir Mesolithic subsample. At Lepenski Vir itself, the change is pronounced at the time of Mesolithic/Neolithic transition and very restricted between the Contact and the Neolithic.

It is interesting to note that Lepenski Vir Mesolithic is most different from Vlasac Mesolithic and Lepenski Vir Mesolithic/Neolithic and less, but still significantly different from Lepenski Vir Neolithic. Lepenski Vir Neolithic shows little difference from Vlasac Mesolithic and somewhat more from Vlasac Mesolithic/Neolithic.

The dendrogram in Figure 34 shows that Mesolithic components at Vlasac and Lepenski Vir/Padina are almost the most removed from each other, which is confirmed by the MDS plot in Figure 35. Vlasac Mesolithic and Mesolithic/Neolithic appear to be virtually identical along the second dimension and different along the first dimension where they are pooled by similarity to Lepenski Vir Neolithic. The general outline argues for temporal trend and continuity within the sample with greater variability in the Mesolithic/Neolithic pe-

Trait	HVP	1	LVP	2	LV	3	LV	4	V	5	V	6
no.	mn		m		mn		n		m		mn	
	k	N	k	N	k	N	k	N	k	N	k	N
1	6	11	12	15	2	11	1	8	18	28	12	23
2	11	24	7	19	4	15	8	14	3	36	1	26
3	16	26	20	22	8	19	6	14	20	48	19	32
4	4	19	2	20	5	18	2	12	7	46	5	28
5	7	12	10	12	5	9	4	9	13	30	17	22
6	17	24	19	22	12	22	8	18	23	45	19	30
7	0	17	0	20	2	18	0	18	0	42	2	25
8	4	17	2	18	4	18	5	16	14	44	15	28
11	4	34	0	27	0	20	1	18	6	54	0	28
13	5	24	4	19	6	6	1	5	12	20	4	26
23	1	9	2	9	0	9	0	10	6	24	2	14
24	1	11	1	10	2	11	0	9	0	28	0	15

Tab. 26. "k" and "N" values for traits used in the analysis of subsamples based on site/chronology combination.

site	site			mmd	sd	stand	total	Z	di	S	formula
1	2			FT	FT	FT	n	FT	FT	FT	
1	2	HVPmn	LVPm	0.0205	0.0520	0.3935	37	1.0880	-0.0836	17.3097	ft
1	3	HVPmn	LVmn	0.2698	0.0584	4.6233	34	3.0129	0.1531	30.4878	ft
1	4	HVPmn	LVn	-0.0104	0.0630	-0.1647	32	-0.1692	-0.1364	10.7029	ft
1	5	HVPmn	Vm	0.0959	0.0381	2.5196	56	2.6350	0.0198	27.6085	ft
1	6	HVPmn	Vmn	0.0875	0.0437	2.0041	44	2.5068	0.0002	26.6643	ft
2	3	LVPm	LVmn	0.5018	0.0586	8.5607	32	5.3937	0.3846	51.9135	ft
4	2	LVn	LVPm	0.3109	0.0632	4.9183	30	4.0290	0.1845	38.9387	ft
2	5	LVPm	Vm	0.2715	0.0382	7.1145	55	5.6937	0.1952	55.0150	ft
2	6	LVPm	Vmn	0.1599	0.0438	3.6504	43	3.5494	0.0723	34.8213	ft
3	4	LVmn	LVn	0.1905	0.0718	2.6525	27	1.2510	0.0469	18.2819	ft
3	5	LVmn	Vm	0.2242	0.0459	4.8892	52	3.3118	0.1325	32.8670	ft
3	6	LVmn	Vmn	0.3885	0.0505	7.6860	39	4.1027	0.2874	39.5918	ft
4	5	LVn	Vm	0.1661	0.0507	3.2744	50	2.4544	0.0647	26.2831	ft
4	6	LVn	Vmn	0.1712	0.0553	3.0968	37	3.0302	0.0606	30.6230	ft
6	5	Vmn	Vm	0.1217	0.0300	4.0608	62	3.2961	0.0617	32.7397	ft

Tab. 27. The output of the analysis for site/chronology combination.

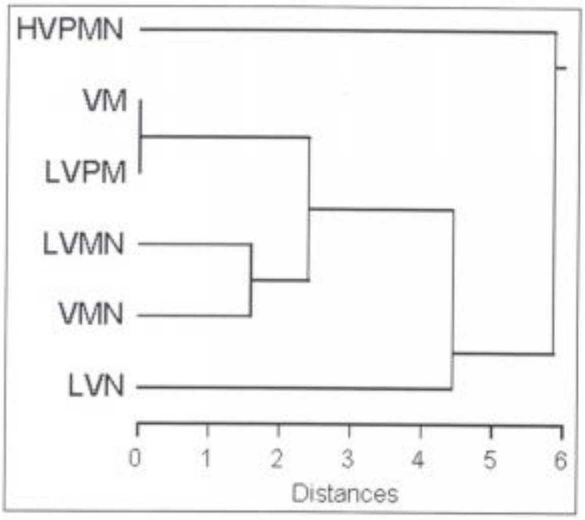


Fig. 34. Dendrogram showing internal relationships of the site/chronology units within the Iron Gates Gorge. Based on dissimilarity matrix, Euclidean distance and complete linkage.

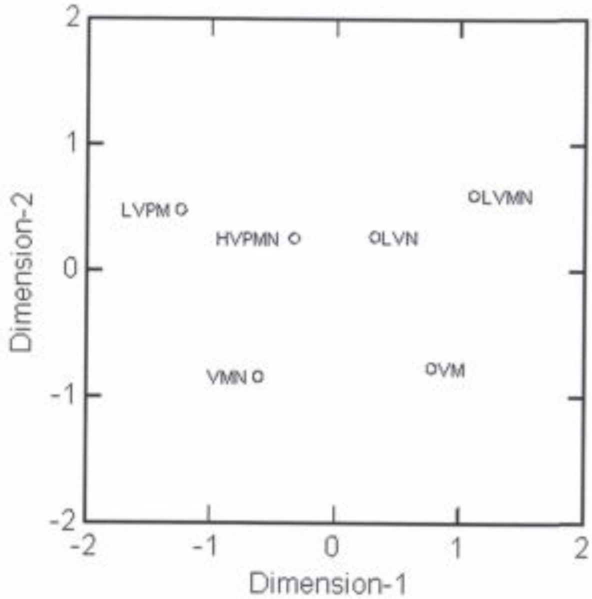


Fig. 35. Multidimensional scaling plot showing internal relationship between the site/chronology units in the Iron Gates Gorge. Based on dissimilarity matrix. Dimensions (1, 2): HVPMN (-.39, .20); LVPM (-1.33, .24); LVMN (.97, .79); LVN (.27, .34); VM (.89, -.63); VMN (-.41, -.95). Kruskal Stress of finalconfiguration: 0.027. Proportion of variance: .993.

riod. While not a definite evidence of insurgence of some new genes in the time of Contact, this pattern presents a strong argument for it.

5.3.3a. Subsamples based on Chronology and Sites with Franzhausen I (Tabs. 29, 30 and 31)

Analysing the site/chronology combination with Franzhausen aimed to clarify the extent of the importance of differences between these different subsamples, and more specifically, the way in which these different groupings are related to each other once an outlier is introduced.

According to the "di" values in Table 30, several distances are non-significant: Lepenski Vir Mesolithic/Neolithic shows little distance from the Neolithic period at the same site. This is, in itself, a strong argument for local continuity at the site in the period of shift in the economic base.

Another feature of interest is the association (continuity) between the two periods at Vlasac. Such a strong association raised doubt that the chronological determination provided by Radovanović (*1996a*), based on stratigraphy and stylistic analysis, could be incorrect. In order to check if this grouping is indeed evidence of continuity, and not the consequence of unreliable separation into different chronological groups, a different designation of chronological units of the sample, based on Srejović's (*Srejović and Letica 1978*) determinations was run through the same procedures.

In order to avoid unnecessary repetition, only the "Z" matrix is presented in the Table 32 as an illustration of the obtained results. Other statistics were scrutinised as well and very little difference was observed.

As shown by comparing the two "Z" matrices on Table 31 for Radovanović's determination and Table 32 for Srejović's, some of the relationships are slightly different in terms of absolute numbers. However, none of the significant relationships change and, more importantly, Vlasac retains practically the same non-difference for its two chronological subsamples. Lepenski Vir Neolithic is equidistant from Vlasac Mesolithic and Vlasac Mesolithic Neolithic. The chronological

Z (ft)	1HVP m/n	2 LVP m	3 LV mn	4 LVn	5 Vm	6 Vmn
1	0					
2	1.0880	0				
3	**3.0129**	**5.3937**	0			
4	-0.1692	**4.0290**	1.2510	0		
5	**2.6350**	**5.6937**	**3.3118**	**2.4544**	0	
6	**2.5068**	**3.5494**	**4.1027**	**3.0302**	**3.2961**	0

Tab. 28. Matrix of Z values for site/chronology combination Significant relationships are outlined in bold.

determination by Radovanović was, therefore, retained, although more direct dates for all of the sites are needed.

As can be seen from the Table 30 and Figure 36, the relationships between different site/chronology units become more complex. Lepenski Vir and Padina in the Mesolithic resemble the Contact period at Hajdučka Vodenica and Padina. This could be due to the fact that Padina is present in both components. However, while the Padina Contact sample is almost the same size as Hajdučka Vodenica in the same period, Padina Mesolithic sample is very small and comparable in frequencies to Lepenski Vir Mesolithic. Therefore it is unlikely that it could pool these two sites together were they different. A strong case of continuity is present between Vlasac Mesolithic and Vlasac Contact. As well continuity can be argued for Lepenski Vir Contact and Neolithic groups. Some shifting and moving of population within the region could explain similarities between the Mesolithic/Neolithic subsamples at Lepenski Vir, Vlasac, Hajdučka Vodenica and Padina. This would coincide with Radovanović's phase of greater territorial integrity and more ideological integration in the region (*Radovanović 1995; 1996a; 1996b*). She argued that this

Trait	HVPmn	1	LVPm	2	LVmn	3	LVn	4	Vm	5	Vmn	6	Frl	7
no.	k	N	k	N	k	N	k	N	k	N	k	N	k	N
2	11	24	7	19	4	15	8	14	3	36	1	26	8	588
5	7	12	10	12	5	9	4	9	13	30	17	22	90	451
6	17	24	19	22	12	22	8	18	23	45	19	30	211	425
8	4	17	2	18	4	18	5	16	14	44	15	28	27	190
10	16	38	12	23	1	18	0	15	18	47	9	29	130	638
11	4	34	0	27	0	20	1	18	6	54	0	28	46	530
12	1	16	3	13	0	9	2	13	9	33	6	26	8	365
23	1	9	2	9	0	9	0	10	6	24	2	14	16	194

Tab. 29. "k" and "N" values for traits used in the analysis of subsamples based on site/chronology combination with Franzhausen I.

site	site			mmd	sd	stand	total	Z	di	S	formula
1	2			FT	FT	FT	n	FT	FT	FT	
1	2	HVPmn	LVPm	0.0236	0.0625	0.3779	40	0.8608	-0.1014	11.2045	ft
1	3	HVPmn	LVmn	0.0638	0.0683	0.9335	37	1.8817	-0.0729	16.5584	ft
1	4	HVPmn	LVn	0.1346	0.0668	2.0161	36	2.5822	0.0011	20.8349	ft
1	5	HVPmn	Vm	0.0891	0.0439	2.0302	61	2.1528	0.0013	18.1553	ft
1	6	HVPmn	Vmn	0.1679	0.0510	3.2912	47	3.3415	0.0659	26.0245	ft
1	7	HVPmn	FRI	0.2940	0.0317	9.2615	444	7.1037	0.2305	60.2433	ft
2	3	LVPm	LVmn	0.2480	0.0708	3.5028	33	3.1803	0.1064	24.8741	ft
2	4	LVPm	LVn	0.4032	0.0692	5.8225	32	4.5975	0.2647	35.8746	ft
2	5	LVPm	Vm	0.1918	0.0462	4.1505	57	3.7504	0.0994	29.0578	ft
2	6	LVPm	Vmn	0.1510	0.0534	2.8303	43	2.9377	0.0443	23.1927	ft
2	7	LVPm	FRI	0.5434	0.0339	16.0297	441	8.7306	0.4756	79.4253	ft
3	4	LVmn	LVn	-0.0231	0.0754	-0.3070	29	-0.1041	-0.1740	7.1021	ft
3	5	LVmn	Vm	0.1954	0.0523	3.7372	54	2.9894	0.0908	23.5464	ft
3	6	LVmn	Vmn	0.1621	0.0593	2.7350	40	2.4154	0.0436	19.7722	ft
3	7	LVmn	FRI	0.1425	0.0400	3.5631	438	3.0453	0.0625	23.9311	ft
4	5	LVn	Vm	0.2797	0.0509	5.4949	53	4.0364	0.1779	31.2792	ft
4	6	LVn	Vmn	0.3378	0.0580	5.8255	40	4.2705	0.2218	33.1581	ft
4	7	LVn	FRI	0.3628	0.0385	9.4119	437	5.9376	0.2857	48.1238	ft
5	6	Vm	Vmn	0.0671	0.0349	1.9210	65	1.8855	–0.0028	16.5800	ft
5	7	Vm	FRI	0.1764	0.0153	11.5023	462	6.3152	0.1457	51.8994	ft
6	7	Vmn	FRI	0.3445	0.0226	15.2427	448	8.1575	0.2993	72.3665	ft

Tab. 30. The output of the analysis for site/chronology combination with Franzhausen I.

integration was brought about by the existence of a different subsistence pattern and different ideology in the region. Availability of contact with Neolithic farmers in the region could have acted to stress the ideological and conceptual unity of the foragers.

Z (ft)	1 HVP m/n	2 LVP m	3 LV mn	4 LV n	5 V m	6 V mn	7 FR
1	0						
2	0.8608	0					
3	1.8817	**3.1803**	0				
4	**2.5822**	**4.5975**	–0.1041	0			
5	**2.1528**	**3.7504**	**2.9894**	**4.0364**	0		
6	**3.3415**	**2.9377**	**2.4154**	**4.2705**	1.8855	0	
7	**7.1037**	**8.7306**	**3.0453**	**5.9376**	**6.3152**	**8.1575**	0

Tab. 31. Matrix based of Z values for site/chronology combination with Franzhausen I. Significant relationships are outlined in bold.

Z (ft)	1 HVPmn	2 LVPm	3 Lvmn	4 LVn	5 Vm	6 Vmn	7 Fr
1	0						
2	0.8608	0					
3	1.8817	**3.1803**	0				
4	**2.5822**	**4.5975**	-0.1041	0			
5	**3.1789**	**3.7119**	**5.3224**	**6.3183**	0		
6	**3.5692**	**3.8970**	**2.6226**	**4.2415**	**2.1087**	0	
7	**7.1037**	**8.7306**	**3.0453**	**5.9376**	**10.8492**	**5.804**	0

Tab. 32. Matrix of Z values based for site/chronology with Franzhausen I. Based on Srejović's chronological assessment.

Figure 37 reveals an even more interesting pattern. Franzhausen, as expected, is far removed from the rest of the sample. The sites examined form a pattern similar to "horseshoe" shape typical of chronological series. However, several features contradict an interpretation of the pattern as reflecting only the change over time. First, Franzhausen is in an unexpected position for chronological change. While it is the furthest removed from the rest of the sites on dimension one, in dimension two it shows less distance and thus does not contribute to the time sequencing. Also, according to the temporal change explanation, the Mesolithic sites should be on one end, Mesolithic/Neolithic in the bottom and Neolithic on the other end of the "horseshoe" diagram. Although the pattern observed reflects this situation to a degree, (observe the Lepenski Vir Mesolithic, Vlasac Mesolithic/Neolithic, Lepenski Vir Mesolithic/Neolithic and Lepenski Vir Neolithic positions), Hajdučka Vodenica and Padina Mesolithic/Neolithic and Vlasac Mesolithic follow a different distribution.

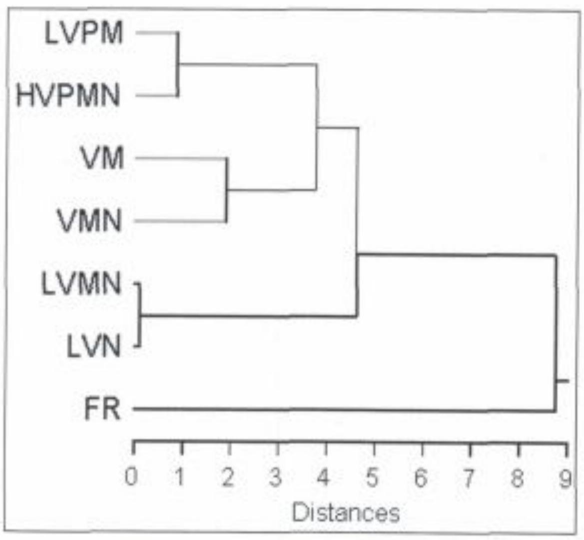


Fig. 36. Dendrogram showing the relationships between site/chronology units and Franzhausen I. Based on dissimilarity matrix, Euclidean distance and Complete linkage.

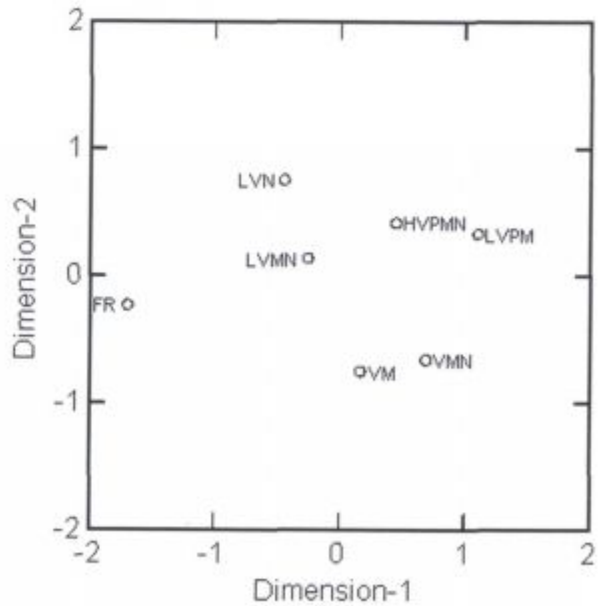


Fig. 37. Multidimensional Scaling showing internal relationships between site/chronology units with the introduction of Franzhausen. Based on dissimilarity matrix. Dimensions (1, 2): HVPM (.46, .42); LVPM (1.10, .31); LVMN. (–.25, .14); LVN (–.42, .77); VM (.15, –.77); VMN (.67, –.69); Franz I (–1.70, –.19). Kruskal Stress of final configuration: 0.064. Proportion of variance: 0.973.

5.3.4. Contribution of traits

Theta values obtained in the Site/Chronology analysis (Ch. 5.3.3.) were submitted to the Principal Component Analysis (Tab. 33, Fig. 38). This, somewhat unorthodox approach was suggested by M. Jackes (*pers. comm.*) based on a published analysis by Christensen (*1997*). Simply stated, 'θ' values are treated as ordinal values and submitted to the PCA in order to ascertain which of the traits contributed the most to the observed pattern. The site chronology analysis being the one on which the interpretation is mostly based, it was deemed unnecessary to subject results of other analyses to the same procedures.

Figure 38 shows the plot of Factor 1 and Factor 2 for the PCA of the 'θ' values obtained for the analysis 5.3.3. The output in Table 33 show that the trait 1 (marginal tubercle 0.90), trait 3 (supraorbital notch 0.92), trait 6 (parietal foramen 0.89) and trait 23 (apical bone 0.80), contribute the most to the first dimension. In real ordinal data this dimension represents the size, here it determines the traits as those with high frequencies. Trait 4 exhibits a strong negative association with the dimension one (supraorbital foramen -0.89), while trait no. 13 (mylohyoid bridge -0.59) shows negative association of a lesser extent. On the second dimension, trait 24 (Inca bone 0.89) has a strong positive association, while trait no. 11 (double mental foramen -0.69) has a strong but negative association. The two components explain 66.6 of the total variation within the sample.

In Varimax rotation (Tab. 34), applied to reduce the number of variables on the "size" axis, Variables 1 and 23 show even stronger positive association (0.97 and 0.98 respectively) while variable 4 shows strong negative association. On the second component, variable 11 shows even stronger negative association, while variable 5 show the strongest positive association with this component. These two components explain 55.7% of the variation in the sample.

Another interesting feature of the PCA analysis is the scatterplot of factor scores 1 and factor scores 2 for the Site/Chronology combination (Fig. 39). More than any other diagram this scatterplot of factor scores shows a "horseshoe" pattern which is characteristic of temporal ordering. Starting with Vlasac Mesolithic in the upper left corner, through Lepenski Vir Mesolithic in Lower left corner, Vlasac Mesolithic/Neolithic in the lower centre, Lepenski Vir Mesolithic/Neolithic in lower right corner and Lepenski Vir Neolithic in Upper right corner. Except for Hajdučka Vodenica and Padina Mesolithic/Neolithic that is positioned centrally, all other units follow the temporal pattern. This indeed can be regarded as strong indication of continuity.

In conclusion to the chapter and as a summary of the analyses, the following interpretation is offered. In general terms, both dendrograms and multidimensional scaling with or without Franzhausen show a strong temporal trend in the data. This is clearly visible in Figure 33 that shows the relationship of the three chronological units with the Bronze Age site of Franzhausen I, and in Figure 39. A significant amount of change within the examined population may be due to non-directional microevolution that is expected for a series covering a time-span of 1500 years. However, as shown by diagrams in Figures 31, 35 and 37, and the position of Hajdučka Vodenica and Padina in Figure 39, the position of different sites/chronology units can not be interpreted as demonstrating a straightforward temporal change. Figure 31 shows significantly more change occuring between Mesolithic and Contact period (due to avai-

Latent Roots (Eigenvalues)

1	2	3	4	5	6
5.0401	2.9539	2.3817	1.1441	0.4803	0.0000
7	8	9			
0.0000	0.0000	0.0000			

Component loadings

	1	2	3	4
V1	0.9061	–0.1902	0.0914	0.3483
V2	–0.0838	0.2467	–0.8662	–0.4264
V3	0.9282	0.3265	–0.0888	–0.1543
V4	–0.8026	0.4243	0.0552	0.0716
V5	0.7571	0.4489	0.4066	–0.2393
V6	0.8946	0.3982	–0.0725	0.0127
V7	–0.4109	0.6277	0.6539	–0.0315
V8	–0.3348	–0.4634	0.7356	–0.3070
V11	–0.2278	–0.6903	–0.5614	0.1728
V13	–0.5891	0.4175	0.0267	0.6585
V23	0.8072	–0.3803	0.1785	0.4010
V24	0.0366	0.8978	–0.3536	0.1874

Tab. 33. PCA output for Theta values of traits analyzed in Chapter 5.3.3.

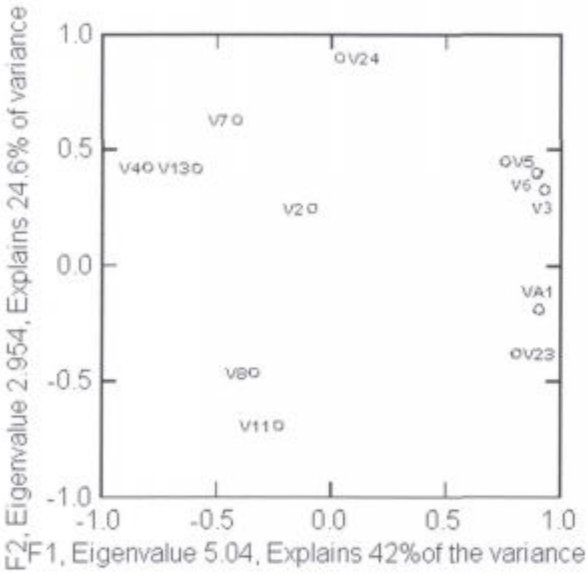


Fig. 38. PCA Factor Scores for Theta values obtained in analysis (Ch. 5.3.3). Variance explained by components: 1 - 5.0401, 2 - 2.9539, 3 - 2.3817, 4 - 1.1441. Percent of total variance explained: 1 - 42.001, 2 - 24.616, 3 - 19.847, 4 - 9.534.

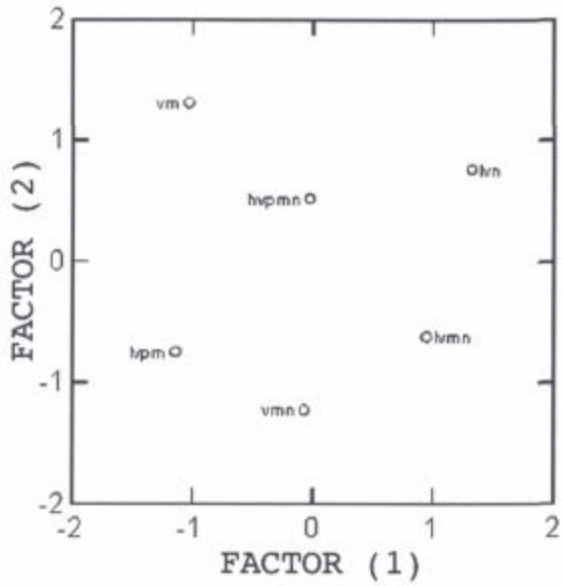


Fig. 39. Scatterplot of PCA factor 1 and factor 2 scores with site/chronology units as labelling variables. vm - Vlasac Mesolithic; vmn - Vlasac Mesolithic/Neolithic; lvpm - Lepenski Vir Padina Mesolithic; lvmn - Lepenski Vir; Mesolithic/Neolithic; lvn - Lepenski Vir Neolithic; hvpmn - Hajdučka Vodenica, Padina Mesolithic/Neolithic.

lability of contact with a different population?) than between Contact and Neolithic. While there is a strong possibility that this results from the situation on one site alone, it can be interpreted as showing a great degree of population heterogeneity during the Mesolithic and/or availability of contact with some influx (but not on a large scale) of new genes from (a) different population(s). The degree of difference of these populations with the indigenous foragers remains, of course, impossible to assess with the current study.

Rotated Loading Matrix (VARIMAX, Gamma = 1.0000)

	1	2	3	4
V1	0.9748	0.1010	0.0652	0.1492
V2	–0.4468	–0.2620	0.7440	0.4220
V3	0.5848	0.4893	0.4623	0.4524
V4	–0.7235	0.0737	0.0293	–0.5501
V5	0.4276	0.8425	0.1079	0.3048
V6	0.6245	0.4965	0.5019	0.2757
V7	–0.4395	0.7166	–0.2264	–0.4832
	–0.2219	0.0959	–0.9464	0.0893
V11	0.0161	–0.9302	–0.0160	0.0872
V13	–0.2559	–0.0350	0.1576	–0.9295
V23	0.9802	–0.0225	–0.1318	0.1019
V24	–0.1509	0.3787	0.8303	–0.3345

"Variance" Explained by Rotated Components

1	2	3	4
3.8798	2.8133	2.7148	2.1118

Percent of Total Variance Explained

1	2	3	4
32.3321	23.4440	22.6232	17.5984

Tab. 34. PCA output for Theta values of traits used in Chapter 5.3.3. Varimax rotation.

After a brief examination of data obtained from metric analyses, these problems and conclusions will be elaborated and presented in the light of research in both anthropology of other series and archaeology of the region.

5.4. Statistical analyses of metric variables

As stated in Chapter 4.2, metric variables reflecting size were subjected to different analyses. Following recommended procedures in Buikstra and Ubelaker (*1994*) left side was used. When not available, the measurement was substituted with that of the right bone. In both ANOVA and PCA tests, individuals originally determined as f and f? were assigned female sex and those determined as m and m? were included as males.

5.4.1. ANOVA tests

Several cautionary remarks are necessary before inference is drawn from ANOVA tests. First and foremost, searching for significance by submitting large numbers of variables to either 't-tests' or ANOVAs is bound to produce significance.

A Bonferroni procedure to establish a protected criterion for 'p' value (*Wilkinson et al. 1996.454*) can be used to guard against the Type I error (detecting significance where none exists). This procedure divides the commonly considered 'p' of 0.05 with the number of traits examined. If, as in the case of sex separation, our results are consistently significant, even when the level is reduced to $p = 0.05/30 = 0.0017$, there is little doubt that any single variable is significant due to chance alone. Bonferroni procedure can induce the Type II error (failing to find significance where a large number of variables is examined). Therefore, in the first analysis (Tab. 35), finding almost all of the variables significantly different between sexes, even with the reduced 'p' value, does in effect mean that the two sexes are significantly different from each other in the given population. The degree of sexual dimorphism illustrated by Figure 23, and p-plots (Fig. 24), and exemplified here through a number of ANOVA graphs (Fig. 40) is remarkable, and while there is some overlap in actual scatters, the two sexes separate almost perfectly on the basis of even one single variable.

Once the significance of difference between males and females was established, ANOVA tests were performed for chronological units, keeping the sexes se-

Dep Var	N	Sq multR	sourc	df	df	F-ratio	P	outliers
CML	34	0.4214	SEX	1	31	22.5807	0.0000	101
CAD	61	0.3609	SEX	2	58	16.3794	0.0000	152
CSD	60	0.3236	SEX	2	57	13.6353	0.0000	
HEB	62	0.3888	SEX	2	59	18.7661	0.0000	115
HVDH	29	0.6490	SEX	2	26	24.0400	0.0000	89
HMXD	79	0.3943	SEX	2	76	24.7406	0.0000	
HMND	79	0.4724	SEX	2	76	34.0289	0.0000	
RML	32	0.6782	SEX	2	29	30.5604	0.0000	
RAPD	71	0.4503	SEX	2	68	27.8544	0.0000	
RMLD	71	0.3128	SEX	2	68	15.4773	0.0000	
UML	28	0.6099	SEX	2	25	19.5404	0.0000	
UMC	54	0.2556	SEX	2	51	8.7557	0.0005	79
FML	40	0.4488	SEX	2	37	15.0615	0.0000	
FBL	37	0.4092	SEX	2	34	11.7759	0.0001	
FEB	38	0.2203	SEX	2	35	4.9433	0.0129	
FMDH	60	0.3846	SEX	2	57	17.8094	0.0000	
FASPD	94	0.1043	SEX	2	91	5.2964	0.0067	50
FMLSD	94	0.1404	SEX	2	91	7.4298	0.0010	
FAPM	90	0.3140	SEX	2	87	19.9084	0.0000	
FMLM	89	0.3320	SEX	2	86	21.3675	0.0000	16
FMC	84	0.3837	SEX	2	81	25.2151	0.0000	
TL	27	0.5613	SEX	2	24	15.3515	0.0001	
TPEB	28	0.4833	SEX	2	25	11.6915	0.0003	
TDEB	42	0.1909	SEX	2	39	4.6004	0.0161	
TMDNF	64	0.3085	SEX	2	61	13.6044	0.0000	
TTDNF	63	0.2685	SEX	2	60	11.0136	0.0001	52,81
TCNF	55	0.4340	SEX	2	52	19.9380	0.0000	81
CCML	41	0.5550	SEX	2	38	23.6966	0.0000	
CCMB	43	0.2664	SEX	2	40	7.2619	0.0020	

Tab. 35. ANOVA output for variables with N>25, showing differences between males and females in particular measurements (for codes refer to Chapter 4.2 – Size and robusticity analyses). Categorical values encountered during processing for variable 'SEX' are: (3 levels) f, m, n.

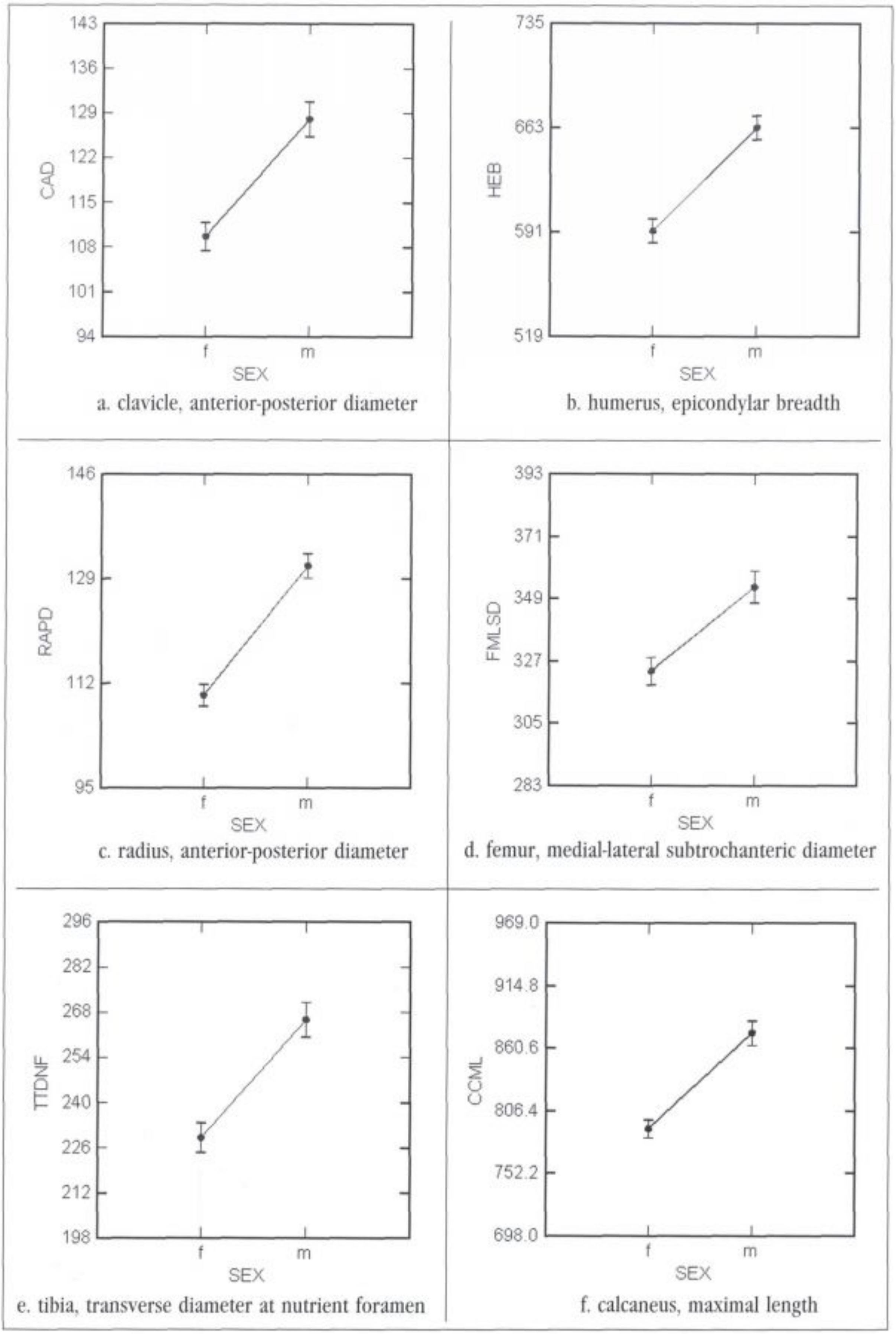


Fig. 40. Sex differences expressed through a series of ANOVA graphs based on the analyses in Table 35.

parate. The first set of analysis was performed on male sample (Tab. 36). Since there were no males with measurable postcranial remains in the Neolithic, the test included only two chronological units: Mesolithic and the Contact (Mesolithic/Neolithic).

Dep Var	N	Sq multR	sourc	df	df	F-ratio	P	outliers
CAD	22	0.0049	CHRO	1	20	0.0986	0.7567	59
CSD	22	0.0100	CHRO	1	20	0.2027	0.6574	
HEB	28	0.0172	CHRO	1	26	0.4560	0.5055	
HMXD	33	0.0228	CHRO	1	31	0.7225	0.4018	
HMND	33	0.0012	CHRO	1	31	0.0376	0.8476	
RAPD	27	0.0099	CHRO	1	25	0.2495	0.6218	
RMLD	27	0.0426	CHRO	1	25	1.1125	0.3016	
UMC	21	0.0049	CHRO	1	19	0.0936	0.7630	28
FMDH	23	0.0658	CHRO	1	21	1.4795	0.2373	
FASPD	34	0.0032	CHRO	1	32	0.1022	0.7512	
FMLSD	33	0.0128	CHRO	1	31	0.4027	0.5303	
FAPM	36	0.0904	CHRO	1	34	3.3786	0.0748	
FMLM	36	0.0318	CHRO	1	34	1.1166	0.2981	7
FMC	33	0.0008	CHRO	1	31	0.0243	0.8771	
TMDNF	22	0.0820	CHRO	1	20	1.7869	0.1963	34
TTDNF	23	0.1543	CHRO	1	21	3.8309	0.0637	20

Tab. 36. ANOVA output for chronological units. Categorical values encountered during processing are CHRO: (2 levels): M, M/N. Males only.

It is obvious that none of the changes from Mesolithic to Contact period is significant even without reducing the 'p' by Bonferroni procedure. The only two variables that show a slightly more important change from Mesolithic to Contact period are TTDNF (0.0637) and FAPM (0.0748), but neither the transverse diameter at nutrient foramen for tibia nor the anterior-posterior midshaft diameter for femur show a statistically significant change between the two periods.

Females were subjected to the same test (Tab. 37). In the first run of the analysis all three chronological periods were kept and the tests were run with 2 degrees of freedom. The aim of the test was to show whether there was any significant change in size variables among females over 1500 year timespan. Since there were three periods in question a post-hoc Tukey test (*Wilkinson et al. 1996*) was run together with the ANOVA in order to ascertain, for those variables that showed significant differences, between which periods the difference appears.

Dep Var	N	Sq multR	sourc	df	df	F-ratio	P	outliers
CML	20	0.0330	CHRO	1	18	0.6143	0.4434	35
CAD	34	0.0921	CHRO	2	31	1.5729	0.2236	66
CSD	33	0.0278	CHRO	2	30	0.4296	0.6547	
HEB	28	0.0939	CHRO	2	25	1.2952	0.2916	20, 43
HMXD	36	0.0938	CHRO	2	33	1.7085	0.1968	20
HMND	36	0.0866	CHRO	2	33	1.5635	0.2245	
RAPD	37	0.2288	CHRO	2	34	5.0441	0.0121	
RMLD	37	0.1174	CHRO	2	34	2.2612	0.1197	
FMDH	27	0.1165	CHRO	2	24	1.5824	0.2263	20
FASPD	44	0.0559	CHRO	2	41	1.2135	0.3076	20
FMLSD	45	0.1679	CHRO	2	42	4.2374	0.0211	49
FAPM	40	0.1466	CHRO	2	37	3.1777	0.0533	
FMLM	39	0.1268	CHRO	2	36	2.6142	0.0871	
FMC	37	0.0616	CHRO	2	34	1.1163	0.3392	63
TMDNF	33	0.0319	CHRO	2	30	0.4947	0.6146	35
TTDNF	31	0.0623	CHRO	2	28	0.9308	0.4061	
TCNF	28	0.0680	CHRO	2	25	0.9123	0.4146	
CCML	24	0.0865	CHRO	2	21	0.9947	0.3866	
CCMB	27	0.2680	CHRO	2	24	4.3929	0.0237	

Tab. 37. ANOVA output for chronological units. Categorical values encountered during processing for variable 'CHRO' are: (3 levels): M, M/N, N. Females only.

Several variables had p values at a level of significance without the Bonferroni procedure. In the case of examining chronological units, 19 variables with more than 20 measurable individuals were subjected to the test. When the reduced value of 'p' was applied (0.05/19 = 0.0026) none of them were significant. They were however examined in order to avoid the Type II error. These are RAPD (Tab. 38) (0.0121), FMLSD (Tab. 39) (0.0211), FAPM (Tab. 40) (0.0533), and CCMB (Tab. 41) (0.0237). For codes refer to the listing of variable labels in Chapter 4.2. While searching for significance is not necessarily an invalid method, the inference based on obtained significance is not as straightforward as it would be with hypothesis testing that involves only a limited number of variables (*Moore 1991.420*).

Upon examining the graphs produced with these variables in Figure 41 it becomes obvious that Neolithic females exert strong influence on the results. This finding in itself would be extremely significant for the present study, but for the fact that the number of Neolithic females with measurable postcranial bones is at most 4. This restricted number cautions against potential bias, and more analyses were deemed necessary. The results of the Tukey "post-hoc" tests on ANOVA show the same. It is also important to note that two of the four significant variables (Tabs. 39, 40, Figs. 41 b, c) show differences only between periods that are the most removed temporally, Mesolithic and Neolithic.

Only two of these measurements show significant differences between Contact and Neolithic period: RAPD, and CCMB. Given that the number of females who belong to Neolithic with these variables measurable is three and two respectively, we can not argue that the results are meaningful. Even if these variables were different between periods without any reasonable doubt, explaining these differences in any of the proposed terms is scientifically dubious.

While the pattern for the four variables shows a significant decrease in size from Mesolithic pre-contact to Neolithic population, they should be considered with great care due to the very restricted number of Neolithic individuals. These trends are observable

Post Hoc test of RAPD. Using model MSE of 91.224 with 34 df. Matrix of pairwise mean differences: 1 M, 2 M/N, 3 N

	1	2	3
1	0.0		
2	0.9848	0.0	
3	−17.8485	−18.8333	0.0

Tukey HSD Multiple Comparisons. Matrix of pairwise comparison probabilities:

	1	2	3
1	1.0000		
2	0.9556	1.0000	
3	0.0124	0.0118	1.0000

Tab. 38. Post Hoc test of radius anterior-posterior diameter. Females only.

Post Hoc test of FMLSD. Using model MSE of 929.631 with 42 df. Matrix of pairwise mean differences:

	1	2	3
1	0.0		
2	−18.8375	0.0	
3	−47.1884	−28.3509	0.0

Tukey HSD Multiple Comparisons. Matrix of pairwise comparison probabilities:

	1	2	3
1	1.0000		
2	0.1265	1.0000	
3	0.0405	0.3028	1.0000

Tab. 39. Post Hoc test of femur medial-lateral diameter. Females only.

Post Hoc test of FAPM. Using model MSE of 1122.611 with 73 df. Matrix of pairwise mean differences:

	1	2	3
1	0.0		
2	−9.9414	0.0	
3	−51.8333	−41.8919	0.0

Tukey HSD Multiple Comparisons. Matrix of pairwise comparison probabilities:

	1	2	3
1	1.0000		
2	0.4180	1.0000	
3	0.0320	0.1005	1.0000

Tab. 40. Post Hoc test of femur anterior-posterior diameter. Females only. Females only.

Post Hoc test of CCMB. Using model MSE of 705.559 with 24 df. Matrix of pairwise mean differences:

	1	2	3
1	0.0		
2	2.9191	0.0	
3	−56.7059	−59.6250	0.0

Tukey HSD Multiple Comparisons. Matrix of pairwise comparison probabilities:

	1	2	3
1	1.0000		
2	0.9645	1.0000	
3	0.0229	0.0237	1.0000

Tab. 41. Post Hoc test of calcaneus maximal breadth. Females only. Females only.

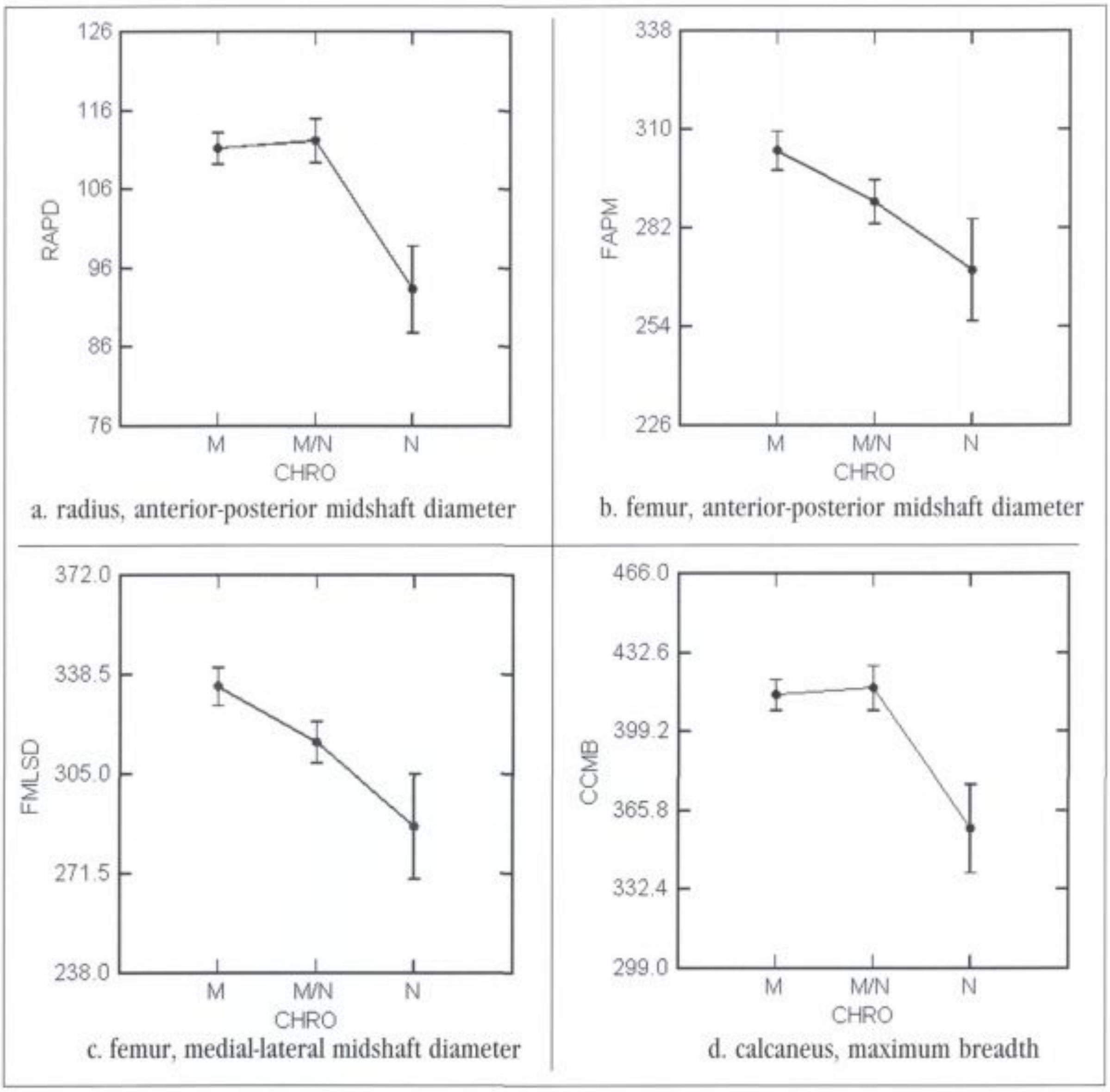


Fig. 41. ANOVA graphs of chronological differences. Variables showing statistical levels of significance. Females only.

in females and need not follow the same pattern in males.

In conclusion, a certain amount of size reduction in several variables shows a secular trend from Mesolithic to Neolithic. These changes could be due to small sample sizes and un-representativeness of the population, or they can be indicative of some degree of size reduction over time.

5.4.2. Principal Component Analyses for metric data

ANOVA tests performed in search of significant differences in variables are an effective tool for appreciating the amount of difference between certain subgroups in the population. They are more appropriate and informative when testing a tight hypothesis, and where the results are more or less consistently significant (as in the case of sex differences in the first test). They should not be used to search for a pattern of grouping or change (*Moore 1991*).

For exploration of the pattern of grouping within the population, a more appropriate method is Principal Component Analysis (*Baxter 1993; Shennan 1988*). PCA is commonly used by archaeologists and anthropologists for morphological (or typological) analysis. The most obvious advantage of the PCA and other multivariate techniques is the ability to provide us with information based on the analysis of more than one variable at the time. PCA also reduces the number of dimensions in which a series of vectors (derived from correlations of variables) can be represented and thus makes observations of patterning of distances between individuals amenable to graphic representation in two or three-dimensional plots.

The conceptual problem that has to be kept in mind in interpreting data derived from these analyses is that, since it is obtained by a series of mathematical operations, that can always be carried out, it need not represent any true patterning (*Baxter 1993:49*). Care should be taken, as with many statistical procedures, not to over-interpret the resulting diagrams. Lack of explicit patterning, especially if the grouping variable is an archaeological observation, could be considered as a strong indication of continuity across chronological periods or homogeneity between cultural groups examined. A brief explanation of the selection of variables, number of factors and resulting scatterplots is offered. Since the number of skeletons that have all of the variables measured is very low, several analyses were run in order to maximise the number of individuals contributing to the factor scores as well is represented on the scatterplots. The first plot (based on Table 42, Figure 42) recapitulates the already obvious distinction between males and females and is offered here only as an example of a plot with an obvious pattern of grouping.

The first set of analysis was run with variable "sex" as grouping variable on the available upper limb bone measurements. Here, of the total computer output, only eigenvalues and variable scores are presented, together with the amount and percent of variance explained by the 2 factors.

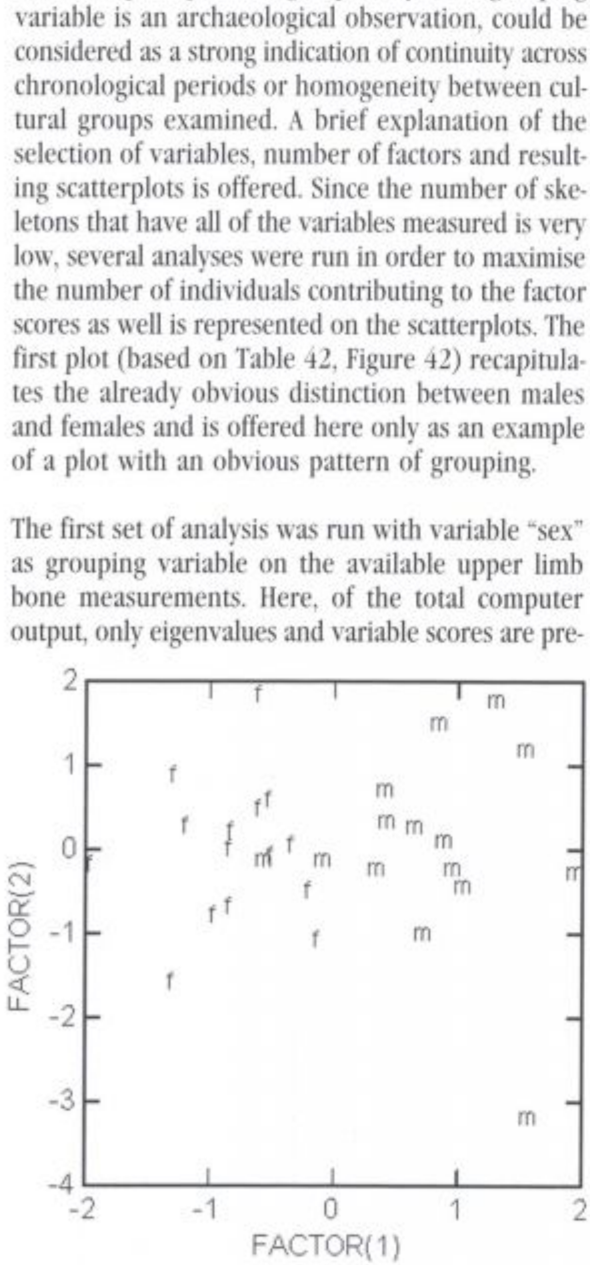


Fig. 42. Scatterplot of factor scores for upper limb bones. Grouping variable sex: "f" for females and "m" for males.

Latent Roots (Eigenvalues)				
1	2	3	4	5
4.6516	0.7521	0.5287	0.4605	0.2675
6	7			
0.2162	0.1234			
Component loadings				
	1	2		
CAD	0.7783	0.2270		
CSD	0.7150	–0.5177		
HEB	0.8656	0.1492		
HMXD	0.7186	0.5663		
HMND	0.9076	–0.2511		
RAPD	0.8931	0.0176		
RMLD	0.8047	–0.1620		
Variance Explained by Components				
1	2			
4.6516	0.7521			
Percent of Total Variance Explained				
1	2			
66.4521	10.7443			

Tab. 42. PCA output for upper limb bone measurements. Grouping variable "sex".

An important feature of the scatterplot in the Figure 42 is almost perfect separation of males and females on the factor (1), and practically no separation on the factor (2) except for the male individual in the lower right corner, Vlasac 26. It is evident that the size (factor 1), plays a major role in the separation of sexes. Following this analysis, the individuals were labelled according to the chronological unit – M (Mesolithic), C (Contact) and N (Neolithic). Three sets of data were examined: a combination of variables of upper limb bones, lower limb bones and a selection of variables that had shown significant difference between Mesolithic and Neolithic in a separate ANOVA test.

As opposed to the previous scatterplot (Fig. 42), the one in Figure 43 (based on analyses in Table 43) does not show any clear separation of individuals by period. The overlap is strong and argues for continuity in respect to upper limb bone size.

Table 44 presents the results for femur and tibia measurements.

As visible from the Figure 44, the measurements of the lower limb show even less patterning.

Latent Roots (Eigenvalues)				
1	2	3	4	5
4.6516	0.7521	0.5287	0.4605	0.2675
6	7			
0.2162	0.1234			

Component loadings		
	1	2
CAD	0.7783	0.2270
CSD	0.7150	–0.5177
HEB	0.8656	0.1492
HMXD	0.7186	0.5663
HMND	0.9076	–0.2511
RAPD	0.8931	0.0176
RMLD	0.8047	–0.1620

Variance Explained by Components	
1	2
4.6516	0.7521

Percent of Total Variance Explained	
1	2
66.4521	10.7443

Tab. 43. PCA output for upper limb bone measurements. Grouped by "chronology."

PCA analysis with variables selected on the basis of significant results in ANOVA tests (Tabs. 36 and 37) on Mesolithic and Neolithic, result - unexpectedly - in a picture of patterning (Tab. 45 and Fig. 45a).

In order to ascertain whether there is indeed a pattern of distribution that argues for a change between Mesolithic and Contact, the scatterplot based on these variables labelled by chronology units is presented together with the one of the same variables labelled by sex in Figure 45a and b.

The superposition of these two scatterplots clearly shows that the pattern of separation along both axes results from small sample size and unequal representation of males and females that have the selected variables measured in the two chronological units.

The only apparent patterning occurs among males, who seem to scatter far more than females. Although the total number of individuals presented by any of these graphs does not warrant overly sophisticated conclusions, this pattern cannot be neglected. The two outliers present among males in Figure 45 - Vlasac 26 and Vlasac 78 - require explanation. They were scrutinised for reconstructed or substituted measurements, since only one (preferably left) side of the individual was recorded. It was substituted with the right bone measurement only in instances where the left bone was missing. This is especially important in the upper limb where lateralisation can induce significant differences between paired bones (*Buikstra and Ubelaker 1994*). During the initial statistical screening I have checked for comparability of left and right bones and since no significant differences were observed in any of the tests, decided that the substitution of left with right bone measurements was acceptable. Both individuals that are definite outliers in the graph have significant number of measurements substituted. Other individuals on the graph, that form a much more homogenous picture, also have substituted measurements, but they differ in respect to the type of the bone. Among outliers, Vlasac 78 has radius and femur substituted, while in Vlasac 26 all three bones that are analysed are substituted. Among those that scatter more consistently Vlasac 50a and Vlasac 17 have all femoral measurement substituted while others have all left bones present. The two outliers were, consequently, removed from further consideration. However, the males still showed less homogeneity than females. Unfortunately, this argument cannot be furthered and explored in more detail, as the number of individuals amenable to this analysis is too restricted.

The results of both ANOVA and PCA analysis suggest heterogeneity of the population in both Mesolithic

Latent Roots (Eigenvalues)					
1	2	3	4	5	6
6.5071	0.5354	0.3590	0.1980	0.1429	0.1138
7	8				
0.1127	0.0311				

Component loadings		
	1	2
FMDH	0.8433	0.4106
FASPD	0.8697	–0.2063
FMLSD	0.8703	–0.3814
FAPM	0.9733	0.0919
FMLM	0.9273	–0.1372
FMC	0.9373	–0.1645
TMDNF	0.9222	0.0619
TTDNF	0.8636	0.3473

Variance Explained by Components	
1	2
6.5071	0.5354

Percent of Total Variance Explained	
1	2
81.3382	6.6924

Tab. 44. PCA output for lower limb bone measurements. Grouped by "chronology."

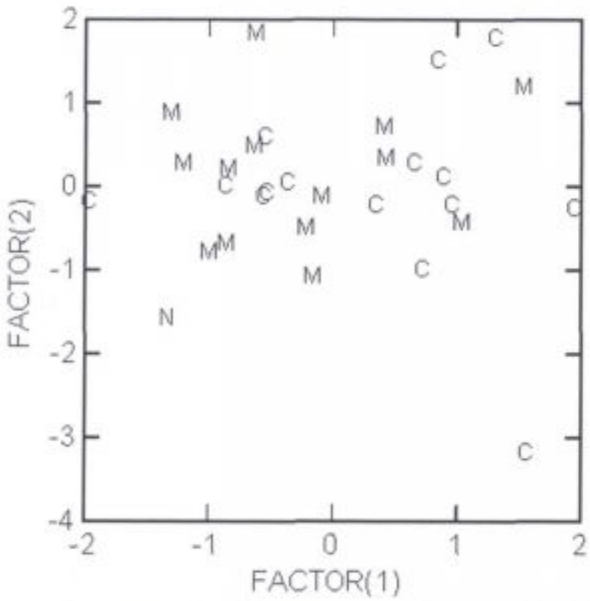


Fig. 43. Scatterplot of factor scores for upper limb bones. Grouping variable chronology: "M" for Mesolithic, "C" for Mesolithic/Neolithic contact period and "N" for Neolithic period.

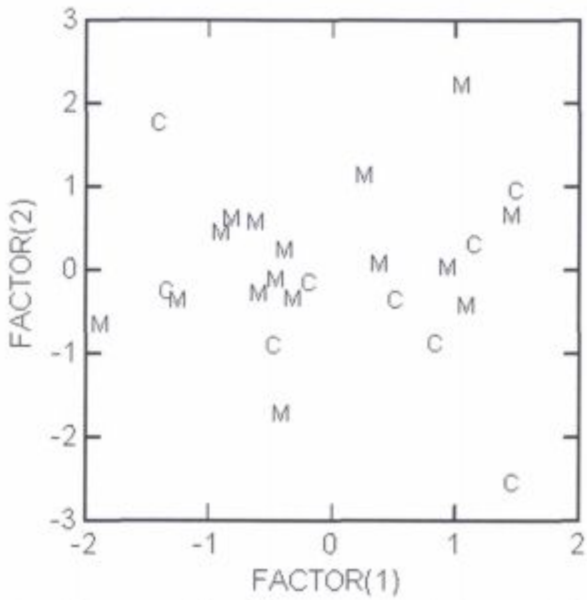


Fig. 44. Scatterplot of factor scores for lower limb bone measurements. Grouping variable chronology: "M" for Mesolithic and "C" for Mesolithic/ Neolithic contact period.

and Mesolithic/Neolithic Contact period. It is difficult to draw any conclusions about the Neolithic population considering that only females could be examined, however, on the basis of the analyses presented, there is no reason to suppose a different pattern for the Neolithic. Further, no clear distinction between the three periods can be made on the basis of either single measurements or a combination of measurements. Although examining different sets of variables and rotating the PCA could produce an explicable pattern eventually, as even random numbers will take on some form of patterning in repeated trials, the presented evidence does not warrant such an exercise since the picture presented across different methods is consistent.

Latent Roots (Eigenvalues)

1	2	3	4	5	6	7
5.5315	0.6272	0.3505	0.2028	0.1394	0.0937	0.0548

Component loadings

	1	2
HMXD	0.8351	0.3499
RAPD	0.9252	–0.0891
RMLD	0.7289	–0.6480
FMDH	0.9283	–0.1310
FASPD	0.8948	0.0969
FMLSD	0.9415	0.1766
FMLM	0.9476	0.1385

Variance Explained by Components

1	2
5.5315	0.6272

Percent of Total Variance Explained

1	2
79.0214	8.9606

Tab. 45. PCA output for a combination of significant measurements. Grouping variable "chronology." Both males and females.

6. DISCUSSION

In the following sections comparisons will be made between the results presented here and previous research on morphometric analysis (Ch. 6.1). The influence of archaeological interpretations on conclusions reached by anthropologists is discussed in Chapter 6.2. and 6.3. reviews observations of biological phenomena that were derived independently of archaeological interpretation. Interpretation based on several lines of inference is offered in the Chapter 7.1 and a review of planned future research is made in Chapter 7.2.

6.1. Insights from previous anthropological research

As already mentioned, most of the previous anthropological research in the Iron Gates Gorge was based on comparisons of metric data for the two sites that had yielded larger numbers of measurable cranial

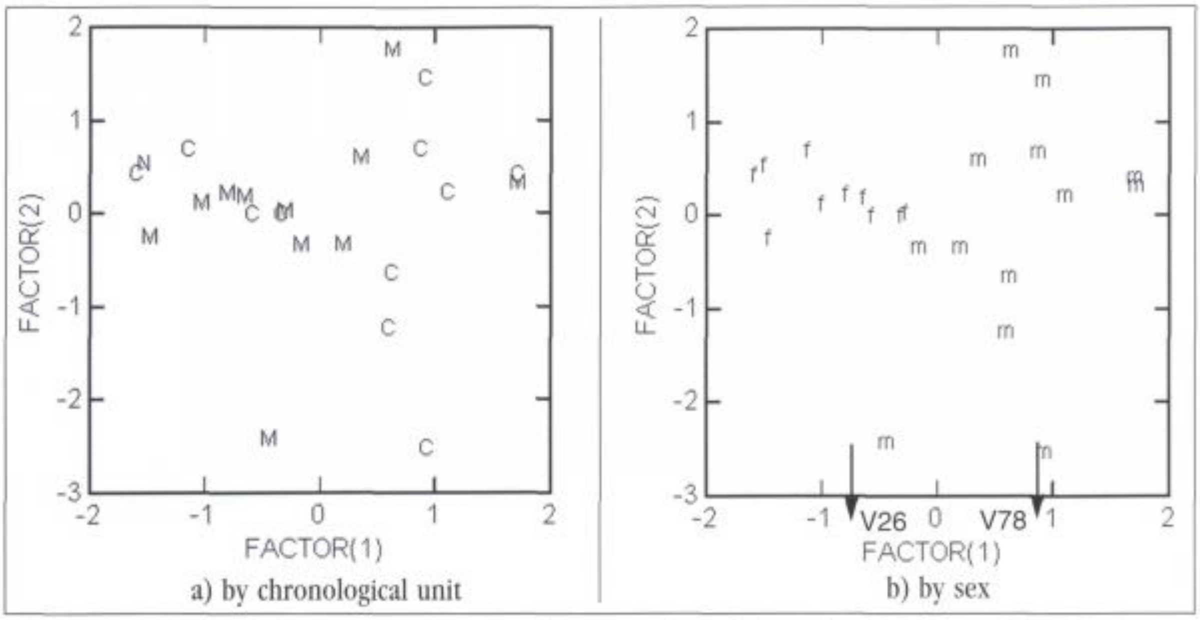


Fig. 45. Scatterplots of factor scores for a combination of variables with grouping variables a) chronology and b) sex.

remains, namely Vlasac and Lepenski Vir. One of the first syntheses came from Nemeskeri and his colleagues (*Nemeskeri 1969; 1978; Nemeskeri and Lengyel 1978b; Nemeskeri and Szathmary 1978a; 1978b; 1978d; 1978e*). Nemeskeri's research was very influential and remains one of the most comprehensive studies of the Vlasac material. Here, the conclusions of his research are presented in light of the questions investigated in the present study.

In a comprehensive study of Vlasac osteological material, Nemeskeri and Szathmary (*1978a.178*) conclude that, in view of the time-interval covered by the series, the variations of quantitative and qualitative traits do not indicate any significant heterogeneity. They, however, observe certain differences between chronological sub populations in which heterogeneity is more pronounced within the male and far less pronounced in the female group. In this work, the same results are indicated by the PCA scores scatterplot for a selected number of measurements in Figures 42 and 45b. These figures show greater spread of males along both axes while females tend to cluster more tightly. The measurements and indices of the facial skeleton in females show homogeneity while in males they do not. An inverse pattern, with females more variable than males, is observed only in the case of the neurocranium.

Although the authors rightly caution against too strong a reliance on the analysis based on such a restricted number of individuals (1.5 to 2.7 individuals per generation, not all of which were sufficiently preserved to allow all observations and measurements), they proceed with distinguishing two major taxonomic units with further subdivisions.

These taxonomic units, described as "A" and "B," follow the general chronological outline proposed by Srejović and Letica (*1978*). While the first sub group was represented by an Upper Palaeolithic local population similar to Brünn-Predmosti type (A-1) with two distinct local variants, Cro-Magnon characteristics were present in sub group A-2. The B type is characterised by two phenomena, (1) mixed occurrence of type A-1 and A-2 characters; and (2) a significant and gradually growing tendency for gracilisation. Further subdivision of type B gives the B-1 form, parallel to the A-2 more archaic form, and B-2 form, later in the sequence, that "further developed the peculiarities of the local form A-2 but in a gracile manifestations" (*Nemeskeri and Szathmary 1978b.180*). In Nemeskeri's comparisons with Lepenski Vir, which was viewed by Srejović (*1972*) as presenting phase displacement compared to Vlasac, the local A-1 group would not be present, the A-2 group is of more definite (unmixed) Cro-Magnon type, and the gracilisation is more evident. Furthermore, according to the blood type analysis, females from Vlasac would be more closely related to both males and females from Lepenski Vir than to males from Vlasac (*Nemeskeri and Lengyel 1978a.276*)

In conclusion, Nemeskeri and Szathmary state that the archaic A-1 type might have been the "initial ethnic stratum at Vlasac" followed by a migration of another local type. The formation of the A-2 subtype (characterised as Cro-Magnon "race") in the Iron Gates population preconditions the intensification of the ethnic contact. From it a mixed type B arises, and in later phases becomes more gracile. At Lepenski Vir, which starts slightly later in the Vlasac sequence, the first local Brünn-Predmosti type would be missing and the population would be characterised by the "Cro-Magnon race and its subtypes" (*Nemeskeri and Szathmary 1978b.182*).

Given recent understanding of problems associated with "racial taxonomy" (*Jacobs et al. 1996*), these conclusions could be either rejected or incorporated into a different understanding of population genetics and micro evolutionary changes. Given the great experience and wealth of knowledge (albeit within a different paradigmatic approach) of Nemeskeri, it would be presumptuous to disregard his findings. If his findings are red without the taxonomic labels that he has put on them, a clearer picture can be gained from his conclusions. Several characteristics of the population can be identified:

- Great heterogeneity within the local Mesolithic population. This coincides with the conclusions of independent examination of sites/chronology units in 5.3.3a and is well demonstrated in Figure 37.
- Greater heterogeneity within the male group and greater homogeneity within the female group. Similar conclusions can be derived from the metric analysis of the postcranial skeleton in Figures 42 and 45b.
- Temporal trend of gracilisation. Although it could be indicated by some of the results in the ANOVA tests (Tab. 37 and Fig. 41), the findings of this research do not support the conclusion. Further, the small sample size in Neolithic does not permit any firm conclusion.
- Trend toward homogenisation of the population in later phases that Nemeskeri attributes to greater inter-group gene flow. This could be supported by stronger clustering of Mesolithic/Neolithic components from different sites in Figure 34.

In this generalised form, Nemeskeri's findings correspond, to a great extent, to the results of the current research. However, the fine-grained distinctions, that the authors made in the discussion on the basis of such restricted material evidence - even within the framework of the "anthropotypology" - are not as convincing.

Nemeskeri and Szathmary's conclusions were based on analysis of Vlasac, regarded as a sub population within the Iron Gates population. Concerning the Lepenski Vir material, in a preliminary report Nemeskeri (*1969*) concludes that the Mesolithic strata contain the finds of Cro-Magnon type, while the Neolithic strata show most probably three distinct types belonging to the Mediterranean taxon.

The first synthesis on the Iron Gates material comes from Mikić (*1980; 1981a; 1981b; 1988; 1992*). Following general divisions into A and B types outlined by Nemeskeri and Szathmary, Mikić developed an explanatory scheme that accounts for possible processes that could have induced the change within the series (*Mikić 1981a.104, Fig. 1*). In his first synthesis of the material, strongly influenced by Srejović's appreciation of indigenous Lepenski Vir cultivation and domestication, Mikić proposes that micro evolutionary trends at Lepenski Vir could account for gracilisation as a consequence of neolithisation. He has introduced another set of "types," all based on generalised "Mediterranean" morphology: 'Longheaded Mediterranean', 'Lepenska variety of Mediterranean', and 'Robust Narrow-headed Mediterranean.' All of these were derived through micro evolutionary processes from the "Cro-Magnon" type. This micro evolution occurs within the layer II of Lepenski Vir, and subsequent changes in both shape and size of the skeletons occur without interruption into the Neolithic, eventually producing 'Gracile Mediterranean' and 'Generalised Mediterranean' types. The introduction of the 'Mediterranean' label, however, does not imply the movement of Mediterraneans into the region, and he argues for local evolution from one "type" to another. Abandoning the typological classification in his later works (*Mikić 1988; 1992*), the author argues for local continuity and isolation stressing the morphological similarities between the Palaeolithic Climente specimen and Late Mesolithic and even Neolithic individuals from Lepenski Vir (*Mikić 1992.40*).

Padina and Hajdučka Vodenica were very summarily treated by Živanović and most of the conclusions were based on archaeological interpretation of the sites. Thus, on the basis of morphological examination, he singles out seven skeletons belonging to the Lepenski Vir culture on the site of Hajdučka Vodenica, attributing all others to the Iron Age stratum (*Živanović 1976c*). Considering that in this research Mesolithic/Neolithic finds from Padina and Hajdučka Vodenica cluster together in all of the analyses performed, and that Hajdučka Vodenica does not show any deviation from other sites in the region when the material is treated as a whole, there are no grounds for this morphological separation. Although Živanović claimed that he has recognised a number of more robust skeletons belonging to the "Padina racial sub-group" and substantially more gracile ones belonging to a much later population (*Živanović 1976c.124*), I was unable to make any such distinction once the skeletons were sexed. This 'Padina sub racial group' is viewed as autochthonous, different from all other known groups and best described as "Obercassel type of the Dinaric race" (*Živanović 1975a; 1975b*). Živanović ascribes to Nemeskeri the conclusion that Lepenski Vir belonged to the same "Proto-Dinaric" population, however, Nemeskeri disclaimed this quote (*Nemeskeri and Szathmary 1978b.180*). In summary, both Hajdučka Vodenica robust individuals and Padina in general are very similar. This finding is confirmed by all of the analyses performed in this research. As opposed to Živanović's interpretation, apart from pronounced sexual dimorphism, no evidence of an extremely gracile group was found at Hajdučka Vodenica.

While Živanović does not discuss the series as a whole, the other authors, working within the paradigm of racial typology, agreed on one important aspect of the material, essential continuity within the region. All of the changes were attributed to microevolution towards more gracile forms with intensification of contacts and admixture at the time of Vlasac II/Lepenski Vir I phases. None of the authors perceives any abrupt change in the Neolithic populations of the region. Schwidetzky and Mikić (*1988*) argue that gracilisation cannot be assumed to coincide with Neolithic adaptation. They reach the conclusion that the high rates of change support the microevolutionary processes in the Iron Gates rather than abrupt change in population (*Schwidetzky and Mikić 1988.117*). It is hard to see how the observed greater degree of gracilisation in Neolithic Lepenski Vir as compared to some other anthropological series, in itself demonstrates continuity. Even more problematic is the grouping of Lepenski Vir II and III into a single unit (comprising 13 measurable skeletons) and a small number of measurable individuals attributed to Lepenski Vir I as only four measurements could be taken on all four individuals attributed to the period. For the other 18 measurements the representation is even worse: 13/28 could not be taken on any individual and 5/18 varied between 1–3 individuals.

Quite a different conclusion was reached by Menk (*Menk and Nemeskeri 1989*). While he also claimed a sharp decrease in robusticity between the Terminal Mesolithic and Early Neolithic of the series, as well as considerable change in shape, the author concluded that the change cannot be explained by local evolution, but rather by a progressive replacement of the population. Menk has applied PCA to cranial and postcranial measurements provided by Nemeskeri (presented here in Figure 46). Missing values were reconstructed by estimation from iterative regression. This approach is problematic as it reconstructs, on the basis of regression, those elements that it sets to distinguish as potentially different. Although it gives more specimens for which the observations can be made, it can either accentuate or distort the observed difference. After computation of the 'z' scores for individuals, the sexes were pooled. The Lepenski Vir material is divided into Mesolithic and Neolithic samples while Vlasac was divided into five samples: 'Vlasac 1', 'Vlasac 1?', 'Vlasac 2/3' and two 'undetermined' samples. As Menk notes, the Lepenski Vir Neolithic sample "fractions into three parts with a remarkable gap in the central part of its area" (*Menk and Nemeskeri 1989. 534*).

In itself, coupled with a small sample size and a problematic pooling of the sexes, this finding can invalidate the analysis since the central value of the Neolithic Lepenski Vir population is derived from the strong dissimilarity of the individuals of which it is made. Similarly, this phenomenon is shown even by those ANOVA plots that do show significant differences among the three periods examined in this work in Figure 41, if we observe the variance around the least square means for the Neolithic sample. In two of the four examples presented (anterior-posterior midshaft diameter and medial-lateral midshaft diameter of the femur) the spread of the values around the means overlaps with the spread of the previous period. The other two measurements (anterior-posterior midshaft diameter of radius and maximal breadth of calcaneus) show a slight increase in size in the Contact period and accentuate the problem of small sample size.

A look at the PCA graphic output for components 1, 2 and 3 that Menk and Nemeskeri offer (Fig. 46), shows strong differentiation along axis 1 (corresponding to size) for Lepenski Vir Mesolithic and Lepenski Vir Neolithic. But, the same is true for the distance between 'Vlasac 1' and '1?' and 'Lepenski Vir Mesolithic'. However, the distance between the two on the 2, 3 axis (measuring some form of shape differentiation) is small. It is, in effect, much smaller than between 'Vlasac 1' and 'Vlasac 1?'. Furthermore, the

Starčevo-Cris Neolithic sample seems to be less, removed on the size axis from Mesolithic Lepenski Vir and practically identical with it on the shape axis (axis 2, 3). The only actual difference between different subsamples on the "shape" axis is between Vlasac 1 and Vlasac 2, 3 that show as much difference on the size axis as Lepenski Vir Mesolithic and Neolithic samples. Unfortunately, while the composition of Vlasac and Lepenski Vir can be reconstructed from Nemeskeri's earlier publications discussed above, no indication is given as to what constitutes the Starčevo-Criş sample, or which measurements were considered in the analysis. The conclusion, although not necessarily wrong, cannot be demonstrated on the basis of the published results, and the explanation given in the abstract seems to be contradictory to the conclusion of the paper. The unfortunate fact that the article was finished by the editors rather than Professor Menk, who died before the paper was submitted, could explain some of these inconsistencies. However, the article offers an interesting view on Mesolithic heterogeneity that is in accordance with all other published results. It is also important that, whenever it was possible to reconstruct from published results, the amount of change seems to be most pronounced in the period that is here understood as Contact.

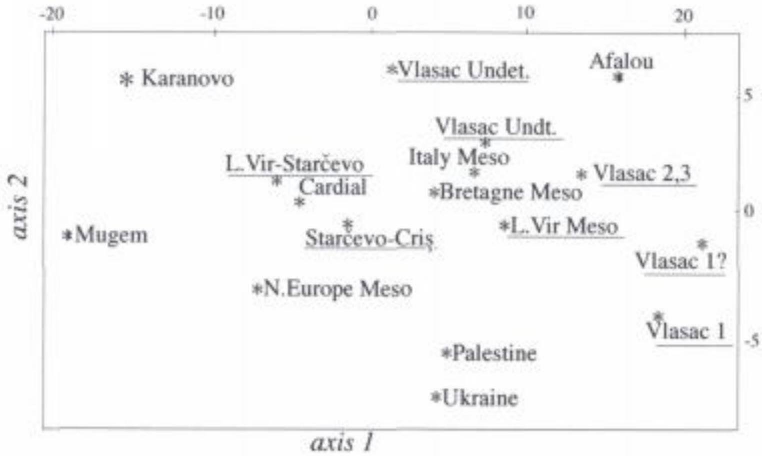


Fig. 46. Menk's scatterplot of PCA scores for different Mesolithic and Neolithic sites. **(Adapted from Menk and Nemeskeri 1989.Fig. 1).**

6.2. Insights from archaeological interpretations of the sites

As we have seen from the previous section, archaeological interpretation has exerted a strong influence on the interpretation of (mostly craniometric) data, not only in the initial divisions of the population according to the chronological data derived from archaeology, but also in respect to understanding general processes in the region. To some extent, the findings of both Nemeskeri and Mikić were strongly influenced by Srejović's (*1969*) initial claim that the neolithisation of the region was a process resulting from the indigenous intensification of plant use and domestication in the region. While this domestication remained within the ritual context for a long time, its ripening into an economic category was eventually accomplished in the Lepenski Vir IIIa phase (*Srejović and Babović 1983*). Accordingly, the Lepenski Vir culture would combine the characteristics of both Mesolithic and Neolithic economy and would eventually become fully Neolithic in its Starčevo (IIIb) phase. In this context, Srejović (*1972*) regarded Lepenski Vir IIIa as an early Proto-Starčevo period derived from the Iron Gates knowledge of agriculture, no longer kept secret from general population by a ruling clan or elders. The food production, until then known only within the ritual context and presumably used as a buffering mechanism, became common knowledge. This brought about the ruin of the social order and changed the mode of life. These provide an explanation for the abrupt change in the elements of architecture and material culture, even though both the major part of subsistence and the population remained the same. In this context, Mikić has explained the gracilisation, evidenced starting from the Lepenski Vir II, as resulting from a larger share of domesticates and plant foods in the diet, boiled now that pottery was available (*Mikić 1988; 1992; Srejović 1969*). Similarly, Srejović's interpretation of the chronological relationship between Vlasac and Lepenski Vir and his ideas concerning the movement of the population within the region is strongly reflected in the typological analysis by Nemeskeri and Szathmary (*1978a; 1978b*) and their claim that Lepenski Vir, not having the first initial Vlasac phase in the sequence also does not have any of the individuals belonging to the most archaic group A-1.

While it is obvious that the archaeological framework strongly influences the anthropological results, and while anthropological patterning cannot be understood without the context of archaeological explanation, the work of Živanović on Hajdučka Vodenica is very illustrative of the inherent problems in preconceived archaeological ideas influencing anthropological finds. As mentioned earlier, Živanović has maintained that he can distinguish between the Mesolithic and the Iron Age components at Hajdučka Vodenica on the basis of morphological and epigenetic traits. This distinction (not confirmed by any of the analyses in the present study) can be understood only in the context of the initial dating of Hajdučka Vodenica into the Iron Age, which was later recognised as wrong by the principal investigator (*compare Jovanović 1966 and 1984a*). A coincidence or a bias? Based on a current analysis of carefully reconstructed individuals and bones, there is no evidence for two different populations. On the contrary, Hajdučka Vodenica seems to be the most homogenous of all the sites, with a possible explanation of this homogeneity in the shorter time-span to which the burials belong.

Regarding Menk and Nemeskeri (*1989*), a different paradigmatic approach can be perceived, that of viewing the Neolithic in Europe (in general), and Balkans in particular, through the wave of advance theory (*Ammerman and Cavalli-Sforza 1971*).

Obviously, archaeological understanding of the processes responsible for observed changes not only have an important influence on understanding the anthropological data, they provide anthropologists with a necessary framework for data interpretation. It would be futile to attempt reconstruction of any past population on the basis of anthropological findings alone, as archaeology provides the necessary 'when', 'where' and possibly 'how' of the interpretation.

In that respect the review of archaeological understanding of the data offered in the Chapters 2 and 3 provides the necessary basis for understanding the observed phenomena. New research in the archaeology of the Neolithic transition, that regards the transition from both Neolithic as well as Mesolithic perspective (*Fischer 1995; Rowley-Conwy et al. 1987; Zvelebil et al. 1998*), new insights into the importance of the economic base for self identification in pre-industrial societies (see discussion in Chapter 2.3), and a shift from a dogmatic view of the transition to agriculture as diffusion of Neolithic invaders (*see Barker 1985 for a critique, also Chapter 2.2.*) needs to be considered and incorporated into a possible explanation of the observed pattern of anthropological data. Most importantly, great variability of population responses to the availability of agriculture (regardless of where the knowledge and the farmers come from), and the changing pattern of relationship over time need to be incorporated into any interpretation.

Confronted with the problem of expectations derived from archaeology which lead to conclusions not always firmly based in anthropology, I have deliberately not put forward any model that should be tested by the current analysis of the data. Of course, some expectations were based on the knowledge of published literature, but these have not necessarily been confirmed. An illustration of this is provided by the problem of gracilisation in the sample. I firmly expected to be able to demonstrate that a group of substantially more gracile individuals can be distinguished in the sample. This observation led to the inclusion of size indicators in the analysis and proved my initial expectations wrong. Size of the postcranial skeleton had no explicit connection with any of the periods, and rather, was a function of sex.

In order to avoid inherent bias in setting up the ideas to test, archaeological inference was consulted only in constructing chronological units. These are based on archaeological understanding of both stratigraphy and stylistic analysis of the burials (*Radovanović 1992; 1996a*). The division of chronological units into three periods based on changes in subsistence pattern was independent of any form of chronological sequencing and different archaeological interpretations. Even absolute dates were avoided in the design of the units. The designation of units is purely economic in the case of the Mesolithic and Neolithic, while Contact or Mesolithic/Neolithic period is determined on the basis of the *possibility* of contact between different subsistence groups often confirmed by presence of a small percentage (<5% suggested by *Zvelebil 1996a*) of domestic animals, introduction of ceramics, and Pre-Balkan plateau flint. Anthropological analysis was performed on independent data that should reflect the biological structure of the population. Statements based on anthropological data that can be regarded as independent from archaeological interpretation are reviewed in the following section.

6.3. Review of independently observed biological phenomena

The archaeological literature strongly suggests that the practice of agriculture is a non-indigenous adaptation in the Balkans. The exact mode of spread of agricultural practices in the region is much harder to ascertain. Although there is evidence of incipient domestication of pig and even suggested possible cultivation of cereals in the Iron Gates Gorge at the time of the Mesolithic Lepenski Vir culture (*Srejović 1972; Srejović and Letica 1978; Carciumaru 1978*), the full integration of the region into the Neolithic complex, recognised by the importance of domesticates - as opposed to wild species (both animals and plants) - happens very late in comparison to the rest of the Balkan Peninsula (Chs. 2 and 3).

The coexistence of Mesolithic and Neolithic modes of subsistence is demonstrated for over 1000 years in the region (*Radovanović 1996a and quoted literature*). In view of a proposed porous frontier between Mesolithic and Neolithic cultures in the studied region (*sensu Dennell 1985 and Zvelebil 1996a*), and traceable in the archaeological evidence, can we recognise the interactions between bearers of these respective cultures in the osteological material?

Skeletal material from all four sites containing human remains from the Contact period indicate that a greater admixture with a non-local population could have occurred at the time of the contact with the Neolithic people. From anthropological data, it is not possible to identify if this admixture occurs between local foragers and contemporary farmers, since a non-local population of foragers could have played an important role in bringing about the change in the genetics of the population.

Since there are not enough data on population biology of the Early and Middle Neolithic in the area, it is impossible to ascertain whether there were any mating networks established between foragers and farmers. Osteological material does not show any significant difference between Lepenski Vir Mesolithic and Starčevo Neolithic population at the one site in the Iron Gates Gorge where both are present. Furthermore, the data presented here argue strongly against the wave of advance model that proposes substitution of local foragers by incoming non-local farmers, even if the substitution is understood as partial and continuous. Therefore, spread of agriculture - in this restricted regional context - should be regarded as the adoption of economic practices by a local population. Furthermore, although cultural traits of Middle Neolithic are recognisable at Lepenski Vir IIIa and IIIb settlement, the adoption of agriculture is only partial, and hunting, fishing, and gathering remain economically important. Lack of abrupt change in activity/ occupation/ nutrition is further evidenced by a very slow change in postcranial metrics of the local population.

Several independent observations can be made:

- A strong case for regional continuity can be argued on the basis of both non-metric and postcranial size data. This is reflected in the pattern of sequence of Mesolithic, Contact and Neolithic against the outlier in non-metric analyses, as well as according to the almost total lack of significant difference among the three groups in metric variables. See specifically the results of analysis 5.3.1a and 5.3.2a in nonmetrics and Tables 36 and 37 in metrics.
- Although a case for a demonstrable degree of size reduction in certain variables can be argued, but only between the earliest and the latest periods, the restricted number of Neolithic skeletons and the fact that only females are represented cautions against over-eager adoption of the gracilisation phenomenon in interpretation. In this respect, the lack of significant difference between all but 4 variables for the whole series is especially instructive. This is even more significant in light of the common assumption that the Neolithic population would have deteriorating health/nutrition status and would be expected to show decrease in size (*Cohen 1977; Cohen and Armelagos 1984*). The expected size reduction was not observed in postcranial measurements in the series to a degree that could argue for a directional microevolution. A slight trend towards decrease in size of most variables is perceived in the Neolithic. This could be due to the restricted number of individuals and not any evident biological phenomenon.
- Non-metric traits show a more pronounced degree of difference between Mesolithic and Contact than Contact and Neolithic periods. In terms of metric data, on the other hand, Mesolithic and Contact are virtually identical, and Contact and Neolithic are more different for all of the significant results in metric analysis (again we need to remember the small sample size and that females only are represented). If indeed this represents a true situation and not a bias caused by a small number of individuals in the Neolithic, this discrepancy could be indicative of different levels of genetic *versus* occupational/nutrition changes. In that case, more genetic change could be proposed at the Contact period and more occupational change for Neolithic proper. Lack of evidence of caries and other oral pathologies in the population (*Frayer 1989*) argues against deteriorating nutritional conditions in the period. A secular trend towards reduction in both midshaft diameters of the femur (Fig. 41) is the only observation indicating size reduction in females over time. A more abrupt decrease in the Neolithic of anterior-posterior midshaft diameter in radius and maximum breadth in calcaneus (again, in females only) is more difficult to demonstrate.

Explaining these observations would involve over-interpreting scanty evidence.

- Based on both the patterning of distance in non-metric traits as well as craniometric analysis performed by other researchers (*Nemeskeri and Szathmary 1978a; 1978b; Mikić 1981a*) an underlying heterogeneity of the pre-contact Mesolithic population is observable. The underlying heterogeneity of the Mesolithic population provides adequate explanation for the observed heterogeneity in the later periods.
- There is a strong degree of sexual dimorphism in the population. This pattern is more evident and differently expressed in the postcranial skeleton than in the cranium. The extent of sexual dimorphism could argue for gender based division of labour associated with greater sedentism and incipient cultivation, as discussed in the Chapter 2.3.
- In terms of metric traits, males seem to be far more variable than females who show greater homogeneity (Figs. 42 and 45b.). This observation is confirmed by Nemeskeri and Szathmary (*1978a*) for Vlasac and Mikić (*1981a*) for Lepenski Vir, based on the cranial metrics. Furthermore, local group exogamy was forwarded as a possible explanation for differences in collagen signals between males and females in both Vlasac and Lepenski Vir (*Bonsall et al. 1997.83*). The blood typing also points to a possible non-local origin of Vlasac males (*Lengyel 1978.275; Nemeskeri and Szatmary 1978a*). Although no method by itself can prove this statement (as all of them have significant limitations); a number of independent observations leading in the same direction provides a good argument in favour of local exogamy and matrilocality. Although greater heterogeneity in male metrics can argue for differentiation in task roles, all other evidence supports the explanation of greater homogeneity of females as resulting from female-based lineage and matrilocality.

The above analysis (Tabs. 46, 47 and 48) was aimed at distinguishing the pattern of difference between males and females in Mesolithic and Contact periods. Neolithic group, being too small when split into male and female samples, was excluded.

Variable no.	MesoF	1	MesoM	2	MeNeF	3	MeNeM	4
1	10	20	20	24	11	19	5	20
2	6	29	5	29	9	33	6	29
3	19	34	21	36	19	36	15	28
4	7	33	2	33	6	32	5	21
5	12	17	12	26	9	17	16	21
6	23	34	19	34	27	40	20	33
7	5	17	6	30	16	37	7	28
8	13	34	14	35	11	37	10	38
11	16	36	3	43	1	37	2	34
13	3	41	5	25	0	23	7	23
23	8	23	9	17	9	16	6	18
15	12	30	6	27	10	24	5	19
17	5	15	11	21	3	20	1	12

Tab. 46. "k" and "N" values for traits. Combination of sex and chronology.

It is interesting to note that three differences are non-significant: between Mesolithic females and Contact males (demonstrated by a negative diFT - Table 47), between Mesolithic males and Contact females and between the two sexes in the Contact period. The most important is the difference between Mesolithic females and Mesolithic males. Somewhat less pronounced, but equidistant are Contact females from Mesolithic females and Mesolithic males.

The dendrogram in Figure 47 shows a pattern of "cross-clustering" that seems hard to explain:

s1	s2	name1	name2	mmdFT	sdFT	Stand FT	Total n	ZFT	diFT	SFT	f
1	2	MesoF	MesoM	0.1123	0.0299	3.7564	59	3.4185	0.0525	33.7378	FT
1	3	MesoF	MeNeF	0.0649	0.0289	2.2480	54	2.4915	0.0072	28.0609	FT
1	4	MesoF	MeNeM	0.0565	0.0296	1.9110	51	2.1880	−0.0026	25.8337	FT
2	3	MesoM	MeNeF	0.0580	0.0281	2.0669	55	1.6662	0.0019	22.2189	FT
2	4	MesoM	MeNeM	0.1125	0.0288	3.9103	52	2.4225	0.0549	27.5466	FT
3	4	MeNeF	MeNeM	0.0913	0.0300	3.0401	51	1.9211	0.0312	23.9509	FT

Tab. 47. The output of the statistical analysis for a combination of sex and chronology.

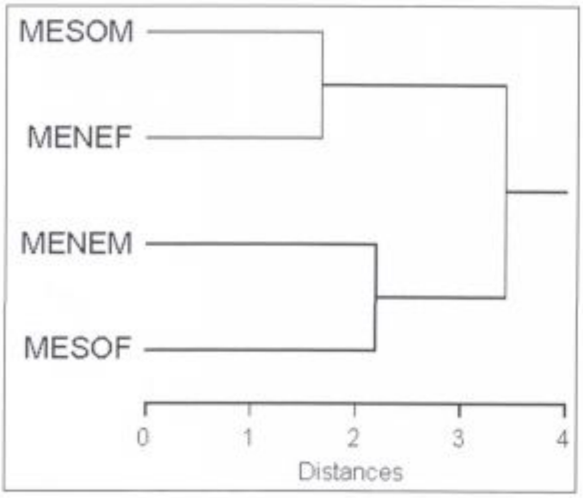


Fig. 47. Dendrogram showing the relationships between units based on a combination of sex and chronology. Based on dissimilarity matrix, Euclidean distance and Complete linkage.

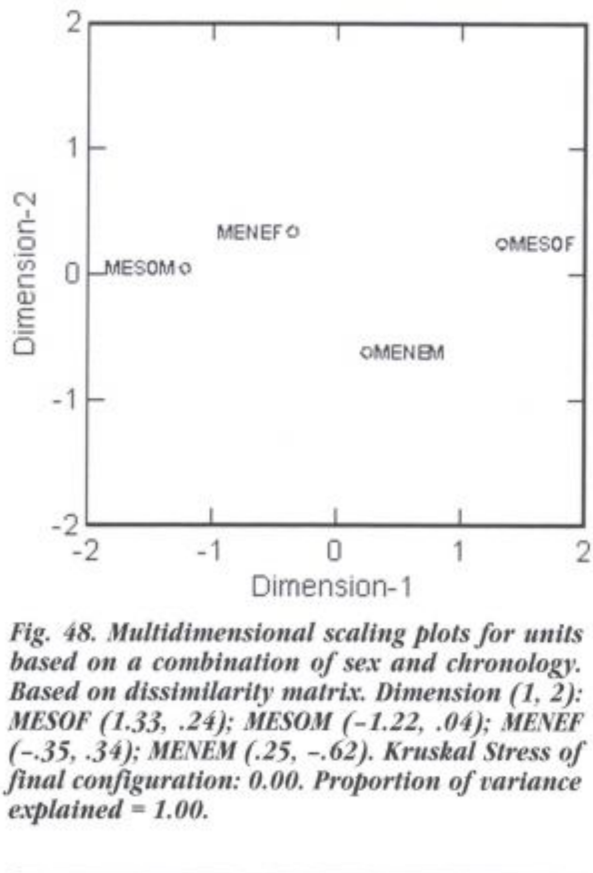


Fig. 48. Multidimensional scaling plots for units based on a combination of sex and chronology. Based on dissimilarity matrix. Dimension (1, 2): MESOF (1.33, .24); MESOM (-1.22, .04); MENEF (-.35, .34); MENEM (.25, -.62). Kruskal Stress of final configuration: 0.00. Proportion of variance explained = 1.00.

	MesoF1	MesoM2	MeNeF3	MeNeM4
MesoF1	0			
MesoM2	**3.4185**	0		
MeNeF3	**2.4915**	1.6662	0	
MeNeM4	2.1880	**2.4225**	1.9211	0

Tab. 48. Matrix of Z values for units based on a combination of sex and chronology. Significant relationships are outlined in bold.

males from Mesolithic cluster with females from Contact and males from Contact cluster with females from Mesolithic. Mesolithic females show as slightly more different from Contact males, than Mesolithic males are from Contact females.

Figure 48 shows much more clearly the greater homogeneity of females who, although they are as much removed on the dimension 1 as the male sample, appear practically indistinguishable in dimension 2. Males, on the other hand, are much more distant on the second dimension. This points towards a more homogenous picture for females in the two periods and could argue for matrilocality.

The fact that Mesolithic males and females are the most removed on the first dimension, and only slightly removed on the second as well as very similar to Contact females, while Contact male sample seems to be the most removed from all of them could suggest that:

- some males from a more distinct male group moving in at the time of contact and
- greater homogenisation at the time of contact.

7. CONCLUSION

7.1. Combining the Lines of Interpretation

In view of the proposed porous frontier between Mesolithic and Neolithic cultures in the studied region, can we presume interactions between bearers of these respective cultures? What forms did these interactions take? Was neolithisation their ultimate consequence?

Interactions, understood at large, involving any amount of change within a population and resulting from the availability of contact or presence of another population, can be assumed even without any specific explanatory mechanism. It is improbable that two populations existing in a relatively restricted geographic area would never interfere or interact with one another (*see Gregg 1991a for an overview of scope of proposed interactions*). Beyond assumptions, the contact between groups with distinct material culture, which in the case of Balkan archaeology correspond well to subsistence groups, is evidenced on many of the sites in the region through the exchange of trade items. The question is therefore centred more on the nature and consequences of this contact than on its existence.

First it is important to stress that this contact need not be uniform and could have been site specific. For example, while there is no evidence for ceramics at the Contact period in Vlasac, Hajdučka Vodenica is rich in potsherds, and ceramics were found *in situ* in Padina houses. Is the close clustering of two periods at Vlasac indicative of greater isolation of Vlasac as a specific locality? Or, is it a consequence of poor chronological separation of a number of skeletons? On the basis of repeated analyses performed on different chronological assignment for the studied individuals, which gave the same results, the latter suggestion seems unlikely, however, it still remains a possibility and argues for more direct AMS dates for the whole series.

In terms of anthropological change within the period, some regrouping of the population is evident. Vlasac seems to be very closed and little population admixture occurs at the time of availability of contact. Similarities between Padina and Hajdučka Vodenica and Lepenski Vir seem to point towards greater mobility within the group as a result of possible pressure from the outside. In Radovanović's terms (*Radovanović 1996b; 1996c; 1996d; Radovanović and Voytek 1997),* this period is a phase of consolidation of the Lepenski Vir culture, of greater ideological integration and most probably associated social differentiation. This ideological consolidation and realisation of some form of unity among the previously dispersed and distinct sites is evidenced by greater insistence on art and ritual. Accordingly, all of the sites on the right bank examined in this study prosper during this period, and the increase in number of graves seems to reflect this greater care for rituals and ancestors.

Can the observed difference between Mesolithic and Mesolithic/Neolithic populations be attributed to admixture between the existing local sub populations of the Mesolithic Iron Gates Gorge, or does it provide evidence for the influx of other, more remote, genes?

The observed differences between the chronological units examined seem to be largely due to a secular trend. At the time of the first contact with Neolithic population a more important change in the genetic profile of the population occurs. This indicates higher levels of admixture with a non-local population. It could have been brought about by an influx of non-local foragers, by an influx of surrounding farmers, or both. In order to answer this question with certainty, a better understanding of local Neolithic populations as well as a wider base of the Mesolithic Iron Gates populations (both from the Romanian side of the Danube as well as from the sites situated more inland) would be needed. Neither was available for this study.

The Neolithic site of Velesnica contained only three female skeletons, while Ajmana (with 17 individuals) was not available for study at the time of this research. The published report by Radosavljević-Krunić (*1986*) does not give enough information for the inclusion in any of the performed statistical analyses. On the Romanian side, only Schela Cladovei has yielded a significant number of individuals (62) that are still under study (*Sweeney at al. 2000*), while a survey beyond the banks of the Danube on both Romanian and Serbian sides is yet to be undertaken.

Based on the data presented here, the distances between Mesolithic components of Vlasac and Lepenski Vir and Padina seem to be important. The great heterogeneity of the population observed by other researchers also support this finding. However, a simple trend towards homogenisation in the Contact period, would have resulted in pooling of the Mesolithic/Neolithic component in these sites somewhere towards the equidistance from the earlier components. This is not the case. As stated earlier, Vlasac seems to remain the most isolated while an important degree of similarity is observed between Lepenski Vir Mesolithic and Hajdučka Vodenica and Padina Contact periods. Some, although minor, introduction of new genes is possible. Ascertaining either that they come from the surrounding Neolithic people or other people moving as a consequence of neolithisation of the surrounding region would be overinterpreting the scant evidence.

It is notable that demographic analysis (*Jackes et al. 2000*) strongly suggest migration at the time of Contact where a slight over-representation of adults among the dead can be observed. The Mesolithic/Neolithic sample could indicate a fall in fertility consequent upon a period of instability associated with cultural change and an influx of adults from outside. This would lead to an apparent over-representation of adults. Such an influx could result in a drop in fertility: the drop could be actual, as a result of the changing and unstable conditions, or it could be perceived, resulting from an unbalanced sex ratio among the migrants (an excess of males). Furthermore, although demographic analysis show increase in fertility in Neolithic sample, when combined with Contact period this sample argues for a stable population with total fertility approaching the foragers and not the farmers pattern.

The migrants, according to morphometric and non-metric data mostly males, did not bring about the change in the economy. If hyperginy is regarded as necessarily favouring the farmers, percieved in contemporary societies as dominant (but see discussion in Ch. 2.3), these migrant males could not have been members of agricultural societies. Furthermore, if we do accept that Neolithic brings about the change in the quality of nutrition and consequently, size reduction (*Cohen and Amerlagos 1984; although see Jackes et al. 1997*), the lack of significant reduction in size of the bones between the two periods, would argue against the Neolithic population moving in. Even if we accept that they would have been different in size, their small number and specific mortuary patterns could account for underrepresentation of these supposed "Neolithic" individuals: the original individuals moving into the community would not necessarily be accorded the same ritual status, and the nutritional and occupational habits would account for the lack of distinction in the subsequent generations. Their genetic input would, however, be reflected in the increase of change between the two periods examined.

Although both of the lines of reasoning point towards migrants as most probably the more remote Mesolithic groups moving into the ideological centre or under the pressure from the farming communities, neither direction of hyperginy, nor the size change caused by neolithisation can be regarded as unequivocal evidence. The identity of the migrants will have to be resolved by comparisons to other populations in the region.

If some influx of new genes is probable in the Contact period, the Neolithic in the region, in terms of population biology, represents the continuation of the local Mesolithic. This is evident in both the non-metric traits – where Neolithic helps make the "horseshoe-shaped" curve typical of temporal ordering (*Greenacre 1984*), and in metrics where there is practically no significant difference between the Contact and the Neolithic. Again, a small number of measurable individuals (all of them females) in the metric analysis, and the fact that this period is present only at the Lepenski Vir site, cautions against too strict adherence to this interpretation. It is, however, the most plausible explanation based on the above data.

In conclusion, large-scale population admixture can not be demonstrated from the above data. Some "seeping in" of the population suggested by Menk (*Menk and Nemeskeri 1989.531*), but without the successive replacement that he argued for, can be proposed on the bases of current research. This "seeping in" happens more perceivably at the beginning of the contact, rather than at the time of change in subsistence. Once this change in subsistence does occur, it is not complete. Fishing and hunting still account for the major portion of the animal assemblage in both Neolithic sub phases at Lepenski Vir. Although the reasons for the change in subsistence are beyond the scope of this research, it can be stated on the basis of the anthropological information that it is not brought about by an incoming population. It must be regarded as a consequence of cultural and social factors operating within the Mesolithic of Lepenski Vir itself, which brought about its disintegration.

Mesolithic Lepenski Vir culture is based on the rich riverine environment that tends to support the richer societies and these are not "among the first to make the transition to food production. Rather they appear to be late lasting in historic terms" (*Brinch Petersen and Meiklejohn in press*). The Lepenski Vir Mesolithic successfully paralleled local Neolithic developments over a long period of time. The contacts with the Neolithic population in the region seem to have helped to form an ideological unity of sites and thus bring into full expression the artistic achievements of an already affluent society. Ideological integration evidenced at the time of possible Contact could have resulted from the growing wealth of the sites based on trade in salt preserved foodstuffs (fish from Iron Gates Gorge and wild game from Gura Baciului) as proposed by Tasić (*1998*). Internal conflicts, overexploitation of the environment and innumerable other factors may have played a role in the disintegration of the Lepenski Vir tradition. The biological descendants of Lepenski Vir culture remained at the locality, in smaller groups, and adopted a different material culture and architecture, but retained the same burial practices, and to a great extent the hunting and fishing economic base. The greater percentage of domestic animals and definite use of domesticated varieties of cereals classifies them as a Neolithic group, but in many respects this population remained unchanged. Only within the fully developed Starčevo phase (Lepenski Vir IIIb) and with the change in burial ritual towards more canonised forms (*Antunović 1990*) did this population finally integrate itself into a larger Neolithic community.

7.2. Future research

Many questions remain unanswered in the Iron Gates Gorge. The ritual praxis associated with burials awaits an analysis based on thorough examination of taphonomic and stratigraphic factors and their integration into understandings of Cognitive archaeology. More AMS dates, as well as an attempt to directly study genetic relationships through DNA analysis, is planned for near future, as well as the re- examination of paleodemography and paleopathology. Re-evaluation of the zooarchaeological evidence, with questions of seasonality of the sites as well as nutritional habits, is currently under way. A thorough examination of the ceramics within their site context is planned and we are hoping that more research can be done on plant remains. A survey of the foothills on both banks of Danube is a necessary step toward a more balanced picture of the subsistence, demography and meaning of these very specific sites.

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